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Solar Thermal Power Generation

Quarterly Update July-September 1978



TECHNOLOGY APPLICATION CENTER
 THE UNIVERSITY OF NEW MEXICO
 ALBUQUERQUE, NEW MEXICO 87131

NASA

SOLAR THERMAL POWER GENERATION

A BIBLIOGRAPHY WITH ABSTRACTS

QUARTERLY UPDATE JULY-SEPTEMBER 1978

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of the
TECHNOLOGY APPLICATION CENTER

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THE UNIVERSITY OF NEW MEXICO
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INTRODUCTION

Our quarterly update on Power Generation usually holds the bulk of its material in the first two overview sections on Energy and Solar Energy. In this third quarter however, we have substantial material in each of the remaining eight sections.

A number of reports appeared this quarter under Conservation and include such user-oriented literature as "101 Ways to Cut Home Energy Costs - Right Now" (ST78-12105). Experiences in government policies to affect conservation were also entered from Canada, West Germany, and England.

The section on Economics and Law addressed various issues surrounding "sun-rights," especially at a forum hosted by the National Solar Heating and Cooling Information Center in Maryland (ST78-13134) and in the "State of the Law, 1977" from Washington's Environmental Law Institute. Leading most states with an intensive effort to reduce building energy consumption, several reports on California's Residential Energy Standards were found.

A useful textbook on Wind System Performance (ST78-17145) were previewed this quarter and other recent developments in Wind Turbines were reported by West German researchers.

We have expanded on a section this quarter by adding Photochemical research to our old section on Biomass. This change will relate new material in such research topics as photosynthesis to improve our solar comprehensiveness and again make this bibliography a more user-oriented publication.

Technical Editor
John R. Peck

GUIDE TO USE OF THIS PUBLICATION

A number of features have been incorporated to help the reader use this document. They consist of:

- A TABLE OF CONTENTS; listing general categories of subject content and indexes. More specific coverage by subject keyword and author is available through the appropriate index.
- CITATION NUMBERS assigned to each reference. These numbers, with the prefix omitted, are used to identify references found in the indexes. They are used as TAC identifier numbers when dealing with document order, so please use the entire (prefix included) citation number when corresponding with TAC. An open ended numbering system allows for easy incorporation of subsequent updates in this system, and numbers assigned to new citations will follow directly the last assigned numbers in the previous issue. Citation number of the last reference on each page appears in the upper right-hand corner to facilitate quick location of a specific article.
- A REFERENCE FORMAT; containing the TAC citation number, title of reference, author, corporate affiliation, reference source, and abstract. The reference source tells, to the best of our knowledge, where the reference came from. If from a periodical, the reference source contains its title, volume, page number and date.
- An INDEX OF AUTHORS; alphabetized by author's last name, followed by the reference citation number. For multiple authors, each one is indexed.
- An INDEX OF KEYWORDS affords access to each citation through an assigned set of descriptive terms. All words pertaining to a reference are permuted alphabetically and the corresponding citation numbers appear as many times as there are keywords. These permuted keywords run down the center of an index page, while the remaining keywords are clustered adjacently. A "#" indicates the end of a set of keywords, while a "/" indicates where a set has been cut off within the line due to overflow.
- A LIST OF ABBREVIATIONS used in describing frequently occurring titles or corporate sources.

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10,000 ENERGY OVERVIEWS

ST78 10165 Appropriate Technology: A Directory of Activities and Projects

Integrative Design Assoc., Inc., Washington, D.C.
NSF/RA-77-0064 1977 GPO

The directory is a product of a study by the National Science Foundation as part of an ongoing effort to explore opportunities for future research programs. A growing number of innovators in the field had been developing technologies that incorporated a concern for maintenance of the ecological balance by increasing the use of renewable resources, extending recycling and diminishing waste, and fostering the resource independence of local areas. These technologies had begun to be called appropriate technologies, but before it could be determined whether RANN could make a contribution to the development of this new approach, it was necessary to survey the field to learn from these individuals and groups about the scope of their activities, the legal and technical problems they are facing in moving from idea to application, and their recommendations for federal activity in support of appropriate technology. This directory is, in part, a compilation of the descriptions of activities of the survey respondents.

ST78 10166 Distributed Technologies in California's Energy Future, Volume I

Univ. of California, Berkeley, CA, Lawrence Berkeley Lab.
Avail:NTIS, N78-21623

Alternative energy sources based on renewable energy forms are considered in terms of development of distribution energy systems with emphasis on the California setting. Trends in energy supply and patterns of energy use are reviewed; energy resources are discussed including biomass, solar energy, geothermal energy, and wind energy; and environmental land use factors are considered. Economic, social, and political issues are included. It is concluded that it is possible to run a complex, highly industrialized, post-industrial society entirely on renewable resources internal to the state and that this can occur in the presence of growth in gross state product.

ST78 10167 Distributed Technologies in California's Energy Future: A Preliminary Rept., Volume 2

Univ. of California, Lawrence Berkeley Lab., Berkeley, CA
Avail:NTIS, N78-21635

Given a perspective that places environmental and social impacts at the heart of the energy predicament rather than on the periphery, it becomes essential to compare the impacts produced by alternative energy options systematically, comprehensively, and objectively. The information needed to do this properly, even for a limited set of technologies and a limited geographic and cultural context (e.g., California), unfortunately does not exist. An attempt was made to outline a logical framework for such a comparison and to hang on that framework the partial information that is available on the environmental impacts of some major conventional and nonconventional energy options for California. The objective was to permit at least some partial and preliminary conclusions about this aspect of the soft energy options and to identify those areas where additional knowledge is most badly needed.

ST78 10168 Save Energy: Use More Electricity

Jrnl: Processing, V 23:65, N4, April 1977

The potential of electric processing for materials conservation and energy conservation in industrial plants and recent developments in electroheat technology are discussed.

ST78 10169 The Risks of Energy Shortage in the World Level

Ailleret, P.
10th Conf. Mondiale de L'Energie, Istanbul, Turkey, Sept. 19-23, 1977
Avail:AIAA, A78-27783 Jrnl: Revue de L'Energie, V 28:SP89-SP102, Aug.-Sept. 1977

Without considering political factors, the risks associated with the world-wide depletion of natural resources, primarily petroleum and gas, are discussed. Prospects for the wide-scale development of alternative energy sources are reviewed, noting wind, solar, and biomass energy. Various energy conservation techniques are suggested, including combined electricity-heating power stations and revised standards for automobile construction. General assumptions are made for future energy requirements and potential substitutions for petroleum (by coal or nuclear energy) are suggested.

ST78 10170 Permanent Directory of Energy Information Sources in the European Community

Allaire, E.; Blamoutier, F.; Maurice, M.
 Avail:NTIS, US Sales Only 1975 183 p.

The permanent directory of energy information sources in the European community gives the identification of the sources, the identification of the persons in charge of the information services, the aims and objectives of the organizations concerned. Access to the sources is made via two lists: one for the primary information sources and the other for the documentation centres. Both are entered by permutation indexes: areas/activities, and activities/areas.

ST78 10171 The Search for a Reasonable World Energy Policy; Some Basic Considerations and Options

Attiga, A.A.
 Organisation des Pays Arabes Exportateurs de Petrole, Kuwait
 10th Conf. Mondiale de L'Energie, Istanbul, Turkey, Sept. 19-23, 1977
 Avail:AIAA, A78-27782 Jrnl: Revue de L'Energie, V 28:SP78-SP86 Aug.-Sept. 1977

General observations are made concerning the direct cooperation between oil exporting and importing countries, and the formulation of medium and long-term energy policies on national and international scales. Consideration is given to the position of the oil exporters with reference to the depletion of hydrocarbons and the necessity to reduce their heavy dependence on the export of crude oil. It is suggested that the main factors to be considered in medium and long-range planning are: (1) the diversification of energy supplies, (2) the conservation of oil and gas, (3) pricing oil and gas on the basis of the cost of replacing supplies by other energy sources, and (4) the diversification of the economies of oil exporting countries.

ST78 10172 Energy and Environment: 64th Thomas Hawksley Lecture; Overall Optimization Concept of Energy Sources Diversification

Barrere, M.
 Onera, Chatillon-Sous-Bagneux, Hauts-de-Seine, France
 IME Mtg., March 8, 1976, London, England
 Avail:AIAA, A78-31123 Jrnl: Proc. of Mtg., 27 p. 1978

Solar thermodynamic power plants and electric power plants using the photovoltaic conversion principle are described and energy conservation practices applicable to transport systems (in particular, air transport) and industries are discussed. Details of a 30-KWE power plant with flat-plate collectors and a 300-KWE power plant with cylindrical parabolic collectors are presented. In a study of aircraft energy conservation, the fuel efficiencies of subsonic and supersonic transports are contrasted. The adoption of modular combustor design to improve engine operating efficiency also receives attention.

ST78 10173 Energy in Developing Countries: Prospects and Problems

Baum, V.
 Int. Atomic Energy Agency, Vienna, Austria
 NPFC Conf., May 2, 1977, Salzburg, Austria
 Avail:NTIS, N78-10603/6ST Jrnl: Proc. of Conf.

Requirements for primary energy and electric power in the developing countries are analyzed in the light of projections of population and economic growth, the availability of indigenous energy resources, and input requirements (capital, technology, trained personnel) for accelerated energy development. Possible supplies for such inputs from domestic sources, transnational corporations, multilateral institutions, and through cooperation among the developing countries themselves and between the developing and the developed countries are reviewed.

ST78 10174 Overview of Technological-Economic Models for Energy Policy Analysis

Behling, D.J.Jr.; Cherniavsky, E.A.; Hoffman, K.C.; Jorgenson, D.W.
 BNL, Upton, NY
 Avail:NTIS, BNL-22730 1977 29 p.

A combined technological-economic model has been developed and applied to the analysis of energy policies. The individual models that have been assembled are the Hudson-Jorgenson model of the economy and interindustry transactions, and the Brookhaven Energy

System Optimization Model. Other data bases and fixed coefficient input/output models are employed as data sources and accounting frameworks to support this combined technological-economic model. The combined model has been used to develop long-range projections of energy-economic relationships and to perform cost/benefit analyses of the US energy R and D programs.

ST78 10175 Description and Comparison of Energy Impact Assessment Models

Burnett, R.A.; Fraley, D.W.
BPNL, Richland, WA
Avail:NTIS, N78-21671

During the past few years the need for more comprehensive analytical techniques for assessing the environmental, economic, and social impacts of energy supply-demand systems and related public policy-making activities has increased. The research and academic communities have responded to this need by developing a wide range of models and other analytical tools for energy impact estimation. The models generally fall into two categories, large-scale and specialized. This report examines the general features and shortcomings of current large-scale and specialized modeling efforts from the point of view of energy impact assessment. Characteristics deemed desirable in large-scale energy-impact-assessment models and related studies are discussed. An outline of criteria for describing and comparing such models is presented from which seven large-scale energy models and one impact assessment study are described and compared in considerable detail. Tables are also presented which summarize the results of the categorizations.

ST78 10176 Preliminary Evaluation of a Thermographic Scanning Device for Energy Conservation Studies

Christensen, D.; Brainerd, B.; Goddard, J.
Alabama Univ., Huntsville, AL, Kenneth E. Johnson Environ. and Energy Center
ASEC-78-1 Jan. 1978

A thermal imaging system, the Magnavox AN/PAS-7 point detector/scanning mirror handheld viewer, was used for a series of tests to measure hot spots (or heat losses) in a solar energy heating system on the exterior of a nursing home, a courthouse, and a residence, and on power line transformers and substations. It was concluded that the AN/PAS-7 provides valuable information to aid in the evaluation of thermal systems because of its portability, ruggedness, wide field of view, and adaptability. It can also be an important tool for use in the evaluation of solar energy conversion systems and could be especially useful for the evaluation of solar heating and cooling demonstration sites.

ST78 10177 Analysis of ERDA's National Energy Plan

Coccio, C.L.
GE, Schenectady, NY
Jrnl: Am. Soc. Mech. Engng. Pap. 77-WA/TS-2 1977

This national energy plan begins with five overall policy goals as follows: (A) maintain the security and policy independence of the nation, (B) maintain a strong and healthy economy, (C) provide for future needs so that future life styles are not limited by energy unavailability, (D) contribute to world stability, and (E) protect and improve the nation's environmental quality. Within this general framework, ERDA develops eight technology goals such as "increase the use of essentially inexhaustible domestic energy resources." Programs are then identified under each goal such as solar electric, breeder reactors, and fusion for the example above. A review of the plan shows that some of the more significant items called for in the legislation relating to anticipated program results, costs, and impacts were not described. When Congress became aware of this lack of quantification, letters were sent to ERDA requesting specific responses along the above lines. This paper presents ERDA's subsequently furnished program costs and benefits in the eight technology goal categories of the national energy plan.

ST78 10178 Energy Predictions

Freiwald, D.A.
LASL, ERDA, Los Alamos, NM
Avail:NTIS, LA-UR-77-35 DIATE Conf. Dallas, TX Dec. 8, 1976

Briefs describe 33 charts, graphs, and schematics offering some recent history and perspectives on the world and US energy situation and the problems for survival facing the world. Of interest is Figure 28, showing the Club of Rome's model of the earth in terms of resource consumption, food, money, people, pollution, etc. A computer was asked to extend recent history into the future and results indicate a collapse of the industrialized

system towards an agrarian culture around the year 2025. It is noted that the model did not consider technological initiative or man's willingness to change lifestyles. The final (33) schematic is a guesstimate of noticeable impact timescales, indicating when research of projects on transition or ultimate energy sources at LASL might be expected to yield impact.

ST78 10179 Statistical Utility Theory for Comparison of Nuclear Versus Fossil Power Plant Alternatives

Garribba, S.; Ovi, A.
Polytech. Inst. of Milan, Milan, Italy
Jrnl: Nucl. Tech., V 34:18-37, N1, June 1977

A statistical formulation of utility theory is developed for decision problems concerned with the choice among alternative strategies in electric energy production. Four alternatives are considered: nuclear power, fossil power, solar energy, and conservation policy. Attention is focused on a public electric utility thought of as a rational decision-maker. A framework for decisions is then suggested where the admissible strategies and their possible consequences represent the information available to the decision-maker. Once the objectives of the decision process are assessed, consequences can be quantified in terms of measures of effectiveness. Maximum expected utility is the criterion of choice among alternatives. Steps toward expected values are the evaluation of the multidimensional utility function and the assessment of subjective probabilities for consequences. In this respect, the multiplicative form of the utility function seems less restrictive than the additive form and almost as manageable to implement. Probabilities are expressed through subjective marginal probability density functions given at a discrete number of points. The final stage of the decision model is to establish the value of each strategy. To this scope, expected utilities are computed and scaled. The result is that nuclear power offers the best alternative.

ST78 10180 The Energy Cost of Prospective Fuels

Gartside, G.
Jrnl: Search, V 8:105-111, N4, April 1977

The prospective fuels discussed include those derived from solar energy, either directly and/or through crops, coal and uranium. Coal must become the predominant energy resource again if the importation of energy is to be restricted. Substantial savings of coal could be made by investing coal energy into other energy-producing systems, particularly those using solar energy. The future for solar energy may lie in the extending of fossil fuels rather than in its use as a renewable fuel source in itself.

ST78 10181 A Few Aspects of the Soviet Energy Policy

Grenon, M.
10th Conf. Mondiale de L'Energie, Istanbul, Turkey, Sept. 19-23, 1977
Avail:AIAA, A78-27779 Jrnl: Proc. of Conf. p. SP40-SP49 Aug.-Sept. 1977

Various aspects of the energy policy in the USSR are discussed, noting that 80 percent of Soviet energy resources are located about 3500 km from the centers of consumption. Coal reserves are outlined with reference to the locations of the major basins. These basins are subdivided into those having primarily underground mining operations and those which may be strip mined. Soviet petroleum resources are reviewed in terms of drilling depths, the recovery of low-gravity oils, and off-shore drilling.

ST78 10182 Colder, Darker; The Energy Crisis and Low-Income Americans; An Analysis of Impact and Options

Grier, E.S.
Washington Center for Metropolitan Studies, Washington, D.C.
Avail:NTIS, N78-21656

Personal interviews of a representative sample of US households are presented with data on consumption and costs obtained directly from their utility suppliers. An analysis of the information from both surveys and an assessment of the impact of the energy situation on the lives of poor Americans are given.

ST78 10183 An Overview of US Energy Options; Supply and Demand-Side History and Prospects

Hirshberg, A.S.
JPL, Inst. of Tech., Pasadena, CA
Avail:NTIS, N78-19610

An overview was provided of nonsolar energy policy options available to the United States until solar energy conversion and utilization devices can produce power at a cost competitive with that obtained from fossil fuels. The economics of the development of new usage were clarified in the context of the historic annual rate of increase in US energy demand. An attempt was made to compare the costs and relative efficiencies of energy obtainable from various sources by correlating the many confusing measurement units in current use.

ST78 10184 The Diffusion of the Use of New Energy Technology as a Context for an Overview of Solar Energy Technologies

Hirshberg, A.S.
JPL, California Inst. of Tech., Pasadena, CA
Avail:NTIS, N78-19611

The process by which new solutions to the energy dilemma are generated and used as a context for an overview of solar energy economics and technologies.

ST78 10185 Long-Term Implications and Constraints of Alternative Energy Policies

Hunter, Y.L.; Watt, K.E.F.; Flory, J.E.; Hunter, P.J.; Mosman, N.J.
Univ. of California, Davis, CA
Jrnl: Energy, Oxford, V 1:375-406, N4, Dec. 1976

The authors have used an overview perspective in analyzing how a diverse range of phenomena such as population, price, inflation, transportation, agriculture, international trade, and city design are linked to energy policy. A principle tool used in the study is the hierarchical simulation model speculator. Simulations using speculator indicate some of the long-term implications of current energy policy. For example, a policy in which gasoline prices decline slightly until 1980 and then increase only with inflation leads to a year 2000 wheat price that is 21 percent higher than that produced by a policy which advocates an increase in the price of gasoline to \$1.00 by 2000. Both policies would still require large imports of oil and consequently, would push US agricultural system to a point where necessary production levels could only be met by massive increases in capital (both human and monetary), energy, and water. Alternatively, an energy policy that would increase gasoline prices to a level similar to that in West Germany (about three times current US prices after correcting for ability to pay) would result in lower wheat prices, since consumption would be decreased with concomitant decreases in oil imports and wheat exports.

ST78 10186 United States Energy Policy: An Economic Assessment

Huettner, D.A.
Univ. of Oklahoma, Norman, OK
4th EAE Nat'l Conf., Oct. 3-7, 1976, Cincinnati, OH
Jrnl: Proc. of Conf., Publ. by AIChE, Dayton Sect., New York, NY p. 63-68

Given the United States' current lack of progress toward energy independence and the likelihood that future progress may be equally unspectacular, one might ask whether energy independence is the optimum energy policy choice. This paper will present in three parts an assessment of US energy policy. It examines the relative trade-offs between a policy energy dependence and independence; the actual US energy policy since the oil embargo and determine the extent to which it has furthered energy dependence or independence; and the extent to which changes in current US energy policy would further long-run policy goals. Emphasis is placed on the economic aspects of energy policy choice.

ST78 10187 New Results in the Field of Energetics Concerning the Problems of Nonnuclear Energy Research

Just, T.
Deutsche Forschungs und Versuchsanstalt Fuer Luft und Raumfahrt E.V., Koeln, Germany, F.R.
Forschungsbereich Energetik
Jrnl: Dtsch. Forsch. Versuchsanst. Luft Raumfahrt Nachr., V 20:834-842, Feb. 1977,
In German

Three fields of work of the 'Research Section Energetics' of the 'Deutsche Forschungs und Versuchsanstalt fuer Luft und Raumfahrt E.V.' (DFVLR) are reported on: (1) conversion of solar energy into thermal or electric energy; (2) tests concerning the quantitative determination of single stages during the formation of soot and the oxidation of hydrocarbons during the combustion process; and (3) basic principles for the development of high-energy lasers.

ST78 10188 The Earth as a Solar Heat Engine: Windpower Utilization, Ocean Thermal Conversion, Tidal Power, Waterwave Power, and Biomass Conversion

Kenton, J.
Electric Power Res. Inst., Palo Alto, CA
Avail:AIAA, A78-30745 Jnl: EPRI J., V 3:43-48, March 1978

The utilization of indirect solar energy sources is discussed. New developments concerning the employment of wind power are partly related to research conducted by NASA working in cooperation with DOE. The huge airfoil blades on which modern wind-power machines are based with variable-pitch gears so that the blade angle of attack can be varied to obtain optimal aerodynamic efficiency over a range of wind speeds. The federal wind energy program covers five areas, including program development and technology, small machines for farm and rural use, 100-kw-scale systems, megawatt-scale systems, and large multiunit systems. Attention is also given to wind power problems, approaches for utilizing wave power, techniques for ocean-thermal conversion, tidal power problems, and the prospects of biomass conversion.

ST78 10189 Possibilities of Opening up New Non-Nuclear and Non-Fossil Energy Sources

Lehner, G.
Stuttgart Univ., Inst. fuer Theorie Der Elektrotechnik, Stuttgart, Germany, F.R.
Jnl: Tech. Mitt., V 70:349-354, N6/7, June 1977 In German

As possible non-nuclear and non-fossil new energy sources, one can discuss three essentially different options: tidal energy, geothermal energy, and solar energy. The word solar energy is used here in broad sense including the direct use of solar radiation and the indirect use of secondary energies derived from solar radiation. A discussion of the natural energy resources of the earth leads to an evaluation of the future possibilities for the different options. The potential of tidal energy is very small. Geothermal energy has a much larger potential, but only if one considers the heat stored in 'hot dry rocks.' The technology for its use is not yet available. It may meet economic and environmental difficulties. Thus the future importance of geothermal energy is not clear now. Solar energy finally has an extremely large potential. Technologies for several methods of its more or less direct use are available. The main problems are economic ones. In the long run solar energy should be able to contribute significantly to the solution of the energy problem if the economic problems can be solved. In the short run an appreciable contribution is, however, not to be expected.

ST78 10190 Energy Demand Modeling and Forecasting, Final Report

McHugh, W.M.
Math. Sciences Northwest., Inc., Bellevue, WA
Avail:NTIS, N78-19676 Spons. by NW Energy Policy Project, Portland, OR and
Pacific NW Regional Commission, Vancouver, WA

Results from an all energy econometric demand model were described and preserved. The model forecasts the demand for electricity, oil, natural gas, and coal for the Pacific Northwest as a whole; for the states of Idaho, Washington, and Oregon, separately; and individually for seven distinct economic subregions therein. Individual forecasts were prepared for the residential, commercial, and industrial sectors and (by two-digit SIC code) transportation and irrigation.

ST78 10191 Development of Small-Scale Benign Sources of Energy in France

Probert, D.
Cranfield Inst. of Tech., Cranfield Beds, England
Avail:AIAA, A78-29291 Jnl: Applied Energy, V 4:75-84, Jan. 1978.

The paper reviews French approaches to harnessing 'alternate' sources of energy. Some of these approaches are intended for use in developing countries. Topics considered include solar energy collection for domestic use, power release, direct conversion of solar energy, bioconversion, wind power, the sea as an energy source, and geothermal energy. Agencies involved with each research project are identified.

ST78 10192 Linear Programming Model for Assessing the Regional Impacts of Energy Development on Water Resources

Provenzano, G.

Illinois Univ. Water Resources Center, Res. Rept. no. 126, 104 p., July 1977

This report discusses the development and application of a multiperiod, multiplant linear programming model of an energy production system and associated water supply components. The model simultaneously appraises alternative expansion strategies and operating schedules for steam-electric power generation and coal gasification industries. The model identifies the type, size, location, and sequence of the construction of new energy production facilities; and the levels of energy production and transmission that minimize the costs of meeting demands for electricity and gas over a specified future time period. The model also determines corresponding information about the amount, location, and sequence with which water will be used in future energy production.

ST78 10193 Prospects for Solar Energy: The Impact of the National Energy Plan

Roach, F.; Noll, S.; Ben-David, S.; Bickle, L.; Schulze, W.

LASL, Los Alamos, NM

Avail:NTIS, LA-7064-MS Dec. 1977

The National Energy Plan (NEP) sets as a goal the use of solar energy in two and a half million homes in 1985. A key provision of the NEP (as well as Congressional alternatives) provides for the subsidization of solar equipment. The extent to which these subsidies (income tax credits) might offset the impact of continued energy price control is examined. Regional prices and availability of conventional energy sources (oil, gas, and electricity) were compiled to obtain a current and consistent set of energy prices by state and energy type. These prices are converted into equivalent terms (\$/10⁶ BTU) which account for combustion and heat generation efficiencies. Projections of conventional fuel price increases (or decreases) are made under both the NEP scenario and a projected scenario where all wellhead price controls are removed on natural gas and crude oil production. The economic feasibility (life cycle cost basis) of solar energy for residential space heating and domestic hot water is examined on a state-by-state basis. Solar system costs are developed for each state by fraction of BTU heating load provided. The total number of homes, projected energy savings, and sensitivity to heating loads, alternative energy costs and prices are included in the analysis.

ST78 10194 Thermodynamics and Energy Policy

Rotty, R.M.; Vanartsdalen, E.R.

Inst. for Energy Analysis, Oak Ridge, TN

Avail:NTIS, N78-21643

Thermal efficiency was widely used in evaluating energy exchanges but this procedure gave no consideration to quality of energy being used. Thermodynamics indicated that different energy quantities had different energy quality, and efficient use of energy required a matching of the energy quality supplied to that required for the given task. Thermodynamic efficiency as a figure of merit in evaluating energy exchanges had the advantage of considering energy quality. It did not give information to assist in the trade-offs between resources and the other considerations that were made in the formulation of an energy policy.

ST78 10195 Choices in the Next Energy and Social Revolution

Ryan, C.J.

MIT, Cambridge, MA

Avail:NTIS, TID-28197 July 7, 1977

The purpose of this paper is to provide a context for choosing the energy system that will replace fossil fuels. As fossil fuels, the energy source of industrialization, are depleted, the world enters into the third most important energy and social revolution in the development of civilization. Natural and social systems operate the same principles of energy management. Growth, stability, or decline is determined by the interdependent relationship between energy and structure (energy in natural and social systems). The evolution of civilization over more than a million years can be seen as a successful quest to control greater amounts of energy through social organization in three different energy and social systems: hunting and gathering, agriculture, and fossil fuels (two energy and social revolutions). Many nations based on different energy and social structures have flourished and disappeared throughout history. The cases of Egypt, Rome, and Britain are used to illustrate the dynamic forces that affect the rise and fall of empires, dependence on foreign resources, and the changing purposes of social organization (the influence of energy on nations). The energy perspective of the paper suggests the relationship between

continuous growth and social discontinuity in US history (continuous growth and social discontinuity in the US). The physical and social consequences of future energy alternatives are discussed in terms of an Orwellian, Jeffersonian, and Malthusian type future (The Third Revolution: Orwell, Jefferson, or Malthus). The paper concludes with an endorsement of solar energy as the alternative most likely to afford a stable future in a humanly organized environment.

ST78 10196 District Heating and Cooling Utilizing Temperatures Differences of Chicago Waters

Santini, D.J.; Frigo, A.A.; Kartsounes, G.T.; Harrison, W.
Argonne Nat'l Lab., Argonne, IL
Jrnl: Energy Use Management, V 2, Pergamon Press, Elmsford, NY 1977

The feasibility of using cold water from Lake Michigan and waste-heat water from Commonwealth Edison Company's Fisk generating station to cool and heat the buildings of a redevelopment project in Chicago, the south loop new town (SLNT) project, was investigated. The study proposes using modular water-to-water heat pumps for cooling and heating the project. The modular heat-pump system is very attractive for SLNT from both an economic and energy-savings point of view. The heat-pump system offers an initial reduction in both the required capital investment for the heating, ventilating, and air conditioning (HVAC) system when compared to a conventional system; and also a significant reduction in annual operating expenses. The heat-pump system, however, requires a significant additional capital investment for the water supply and return system. Even with this investment, the heat-pump system savings in annual operating expenses and reduced capital investment for the HVAC system could pay for the cost of the water supply and return system in less than five years. Added to the economic savings would be an energy savings equivalent of about 450,000 barrels of fuel oil per year when compared to a conventional system.

ST78 10197 Assessment of Energy Storage for Electric Utilities

Schneider, T.R.
Public Service Electric and Gas Co., Newark, NJ
CONF-760212 1977

The results of an assessment of energy storage for use by electric utilities are presented. The potential role of energy storage in meeting the demand for low-cost electricity and technical options that provide a basis for development of an effective research and development program are discussed.

ST78 10198 A European Energy Policy - Distant Mirage or Tomorrow's Reality

Simonet, H.
Communautes Europeennes, Conseil des Ministres des Communautes Europeennes, Brussels, Belgium
10th Conf. Mondiale de L'Energie, Istanbul, Turkey, Sept. 19-23, 1977
Avail:AIAA, A78-27777 Jrnl: Revue de L'Energie, V 28:SP15-SP22, Aug.-Sept. 1977

It is suggested that many misconceptions concerning present day energy resources exist. An assessment is made of the achievements and shortcomings of European energy conferences and the policies adopted, noting negotiating positions, plans for developing nuclear energy, financing energy investments, energy conservation programs, and legal measures concerning the development of standards. General proposals are made regarding future plans and goals.

ST78 10199 Toward a California Energy Strategy

Varanini, E.E.III
California Energy Resources Conservation and Development Commission, Sacramento, CA
Jrnl: Energy Use Management, V 2, Pergamon Press, Inc., Elmsford, NY 1977

The California Energy Resources Conservation and Development Commission has identified three points of view of energy strategy: (1) conservation and appropriate technology, termed Jeffersonian; (2) return to government fostering investment and development, termed Greelman; and (3) better government planning and regulation, termed Periclean. Scarcity and the extent to which institutions can deal with it are the key factors that determine the choice of energy policy. The commission concludes it cannot wait until the debate over resource scarcity is resolved. A practical energy policy is needed for the interim and its proposal for such a policy is presented. In general, the policy states that (1) there is security in diversity, benefit in flexibility; (2) known technology should be chosen; and (3) regulation should be avoided when possible. The keystone to the commission's program, conservation, and its other elements are discussed.

ST78 10200 Solar Energy Utilization in the USA

Von Cube, H.L.

Jrnl: Klima Kaelte Ing., V 4:325-329, N9, 1976 In German

This is a report on a study trip to the USA. The trip was made to gain insight into the state of technology concerning solar energy techniques and into governmental promotion measures for developing solar techniques. Economic data, a status report on the present market situation, a development forecast, and some examples of existing solar plants are presented.

ST78 10201 Reflections on the Energy Wars; Solar Vs. Nuclear Power

Weinberg, A.M.

Oak Ridge Assoc. Univ's, Inc., Oak Ridge, TN

Avail:AIAA, A78-30297 Jrnl: Am. Scientist, V 66:153-158, March-April, 1978

The controversy over solar vs. nuclear energy is examined, noting that there is irrationality on both sides, i.e., the nuclear advocates tend to scoff at the practicality of solar power, while the solar advocates often exaggerate the dangers of nuclear power. It is pointed out that the generation of electricity from nuclear power plants is far cheaper at present than would be the comparable power derived from small widely dispersed solar generators. Attention is given to the difficulty of electrical storage in solar power facilities, but also to the possibility of catastrophic accident from nuclear plants. The author advocates a cautious use of nuclear-generated electricity for the short run, with increasing dependence on solar power once a more efficient solar technology comes on-line.

ST78 10202 Helios Strategy: A Heretical View of the Role of Solar Energy in the Future of a Small Planet

Weingart, J.M.

Woodlands Conf., Woodland, TX 1977

Over the next hundred years there must be a worldwide transition from reliance on fossil fuels to the use of some combination of long-term and abundant primary resources for the production of heat, electricity, and synthetic fuels. The rate at which such options can be developed and employed, as well as the maximum rate at which they can provide energy at a sustained rate, will place important constraints on the rate and limits to growth of other human activities. It is generally argued that only the fission option, in the form of the fast-breeder and high-temperature reactors, can provide the energy required for a livable world, particularly if this means a world of ten billion people living at the present energy level of Western Europe. However, the author's examination indicates that the use of solar energy, through a menu of technological options, can provide the needs of a world at this scale of energy use and that this can be accomplished within the constraints of land availability and requirements for energy, materials, and labor. No scientific breakthroughs are required, although a number of these would be helpful, but very substantial engineering advances are required, and the transition to such a system worldwide would take no less than a century. However, the feasibility of such large-scale use of solar energy will substantially alter those aspects of the "limits to growth" discussions in which future growth strategies are constrained by available and acceptable energy alternatives. This paper outlines a global solar energy system considered feasible for more than 10 billion people living at 5 kw per capita.

11,000 SOLAR OVERVIEWS

ST78 11152 Australian Solar Energy Research

Jrnl: Indian East. Engng., V 118:109,113, N3 March 1976

A patented solar energy storage technique is announced. Based upon thermo-chemical reaction stored energy, the Australian development abstracts heat from solar energy collection mirrors using a heat absorbing chemical reaction, the decomposition of ammonia into nitrogen and hydrogen. An array of paraboloidal mirrors is employed to focus solar radiant energy on a focal absorber and heat exchanger which transfers heat to a closed-loop ammonia transmission system. At a central recovery plant, the circulated ammonia decomposition products are resynthesized into ammonia to recover and effectively coradiate the absorbed solar energy. By comparison with a circulating water type solar energy collection system, the new development requires a much smaller quantity of flowing fluid and smaller, lighter, and more economical components can be employed. Other possible applications include production of hydrogen from water and ammonia for fertilizers.

ST78 11153 Industrial Applications of Solar Total Energy, Volume 1, Summary, Final ReportMcDonnell Douglas Astronautics Co., Huntington Beach, CA
Avail:NTIS, SAN/1132-2/1 April 1977

A summary of the program to define solar energy systems that are technically and economically feasible that can satisfy all or part of selected industry demands and to determine the market potential of such systems is given. The primary emphasis was placed on the application of total energy systems where the industrial process heat, electrical demands, and space heating and cooling are satisfied at maximum possible efficiency. Industrial energy usage was first determined, leading to a survey of those which were energy-intensive. The survey yielded the necessary industrial demand data to allow first-level designs to be accomplished. Concurrently with the industry survey, subsystem methodologies were established in the areas of insolation data retrieval, collector performance and sizing, thermal storage, energy conversion, and heat transport. In excess of 40, first-level designs were generated allowing a preliminary ranking and selection of industries for the conceptual design phase. These industries were: (1)meat packing, (2)fluid milk, (3)sugar beets, (4)asphalt materials, and (5)concrete block. Conceptual designs were then generated for each primary location for the industries and three additional locations as dictated by industrial influence zones (IIZ). These designs were used to determine system economics and ultimately market penetration. Volumes II, III, IV, and V of this report contain detailed results.

ST78 11154 Industrial Applications of Solar Total Energy, Volume 2, Technical, Final ReportMcDonnell Douglas Astronautics Co., Huntington Beach, CA
Avail:NTIS, SAN/1132-2/2 April 1977

The objectives of this program were to define solar energy systems that are technically and economically feasible and can satisfy all or part of selected industry demands, and to determine the market potential of such systems. The primary emphasis was placed on the application of total energy systems where the industrial process heat, electrical demands, and space heating and cooling are satisfied at maximum possible efficiency. Industrial energy usage was first determined, leading to a survey of those which were energy intensive. The survey yielded the necessary industrial demand data to allow first-level designs to be accomplished. Concurrently with the industry survey, subsystem methodology was established in the areas of insolation data retrieval, collector performance and sizing, thermal storage, energy conversion, and heat transport. More than 40 first-level designs were generated, allowing for a preliminary ranking and selection of the following industries for the conceptual design phase: (1)meat packing (standard industrial classification 2011; (2)fluid milk (SIC 2026); (3)sugar beets (SIC 2063); (4)asphalt materials (SIC 2951); and (5)concrete block (SIC 3272). Conceptual designs were then generated for each primary location for these industries and three additional locations as dictated by previously determined industrial influence zones (IIZ). These designs were then used to determine system economics and ultimately the market penetration. All of the selected industries yielded positive return on investment in the small central receiver configuration, thereby validating the selection.

ST78 11155 Industrial Applications Study, Volume 3, Technology Data Base Evaluation of Waste Recovery Systems, Final Report

Drexel Univ., Philadelphia, PA; United Tech. Res. Center, E. Hartford, CT; Mathematica, Princeton, NJ
 Avail:NTIS, COO/2862-3 Jan. 1977

An analytical study was undertaken to estimate the present and potential technical and economic characteristics of a wide range of components and complete systems of converting industrial and commercial waste heat into mechanical or electrical power and/or building and process heating and cooling. The component and system technologies evaluated include: Rankine, Stirling, and Brayton-cycle power systems; reciprocating, rotary, and turbo-expanders; heat exchangers and heat pumps; thermally driven cooling and dehumidification systems; and integrated systems capable of providing multiple outputs. Extensive analyses were conducted of Rankine-cycle systems using steam, halogenated hydrocarbons, and other organic compounds as working fluids. Performance characteristics, recoverable output power, and installed costs were estimated and are presented herein for rankine-cycle systems utilizing selected working fluids over a range of waste heat source temperatures between approximately 200 and 1000° F. Data describing the performance capabilities, technology and installed costs of heat exchangers, expanders and thermally driven absorption, vapor compression, steam-jet cooling and cooling and refrigeration systems are presented herein together with limited performance and cost estimates for Stirling-cycle power recovery systems. The component and system data were used to provide a preliminary assessment of the Stirling-cycle power recovery systems. The component and system data were used to provide a preliminary assessment of the recoverable energy and associated system costs when integrated with generalized waste heat sources identified by Drexel University from their two-digit SIC industrial energy survey.

ST78 11156 Industrial Applications of Solar Total Energy, Volume 4, Catalog of First-Level Designs, Final Report

McDonnell Douglas Astronautics Co., Huntington Beach, CA
 Avail:NTIS, SAN/1132-2/4 April 1977

First-level designs have been completed for 24 facilities representing six major industry groups (SIC codes 20,26,28,29,32, and 34), located throughout six southwestern states (Arizona, California, Colorado, Oklahoma, New Mexico, and Texas). First-level designs are carried to the depth necessary to establish the thermodynamic balance and identify performance parameters for the major components of the system, namely, collector fields thermal storage, heat exchangers, thermoelectric conversion devices, and major pumps. All of the first-level designs fall into one of the following generically different thermodynamic cycles or combinations thereof: (A)electricity plus process steam, (B)electricity plus drying heat (hot air), (C)electricity plus process steam plus process refrigeration. Summary descriptions of all first-level designs are contained in this appendix. For the reader's convenience, each facility sizing description is meant to stand alone and therefore many of the figures are repeated. The ground rules, assumptions, and definitions associated with the designs are discussed in Volume 2 of this report.

ST78 11157 Industrial Applications of Solar Total Energy, Volume 5, Catalog of Conceptual Designs, Final Report

McDonnell Douglas Astronautics Co., Huntington Beach, CA
 Avail:NTIS, SAN/1132-2/5 April 1977

Conceptual designs for five industries have been completed (meat packing, fluid milk, sugar beets, asphalt materials, and concrete block). These industries represent three of the major industry groups (Standard Industry Code 20, 29, and 32). Each industry was evaluated at a primary location corresponding to the location of an actual industry whose demand was used in sizing the solar total energy station (STES). Three alternate locations were selected for each industry. In all, 12 locations were analyzed. Six of the locations were assessed for more than one industry. Two different types of collector fields were sized and their performance analyzed for each industry location. The collector types were central receiver and two-axis tracking distributed collectors. One industry, meat packing, was also analyzed using one-axis tracking distributed collectors as well. All of the designs are hybrid in nature; that is, they use auxiliary energy supplied by fossil-fueled heaters during times of reduced insolation. All of the conceptual designs provide 100 percent of the individual industry's annual energy demand, with between 71.8 and 91.5 percent of the energy being supplied by solar depending on industry, location, and collector type. One exception is the sugar beet processing industry where a scaled load was used. In this case, the hybrid STES provides 100 percent of the electrical demand and 25 percent of the process heat. This was done by maximizing electrical generating efficiency at some expense in process heat displacement. Component summaries including major subsystem descriptions and operating parameters are included in tabular form in the appendix for each conceptual design.

ST78 11158 Solar Energy: Book

Ottaviano Technical Services, Inc., Melville, NY 1977

This book is divided into the following seven sections: (1) national energy policy, (2) the justification of using solar energy, (3) data concerning solar energy, (4) products available, (5) applications of these products, (6) economics, and (7) future applications.

ST78 11159 Solar Energy Incentives Analysis: Psycho-Economic Factors Affecting the Decision-Making of Consumers and the Technology Delivery SystemGeorge Washington Univ., Washington, D.C.
Avail: NTIS, HCP/M2534-1 Jan. 1978

Findings are presented from a prototype assessment of the combined economic and behavioral processes by which decisions are made to invest in solar HVAC systems by the various segments of the solar technology delivery system (TDS) and by ultimate users. The rationale for the study is that economic incentives are necessary, but not sufficient for achieving commercial and residential acceptance. For example, sizeable increases in fuel and utility costs have not deterred the manufacture, purchase, or use of conventional HVAC systems and other appliances that consume large amounts of energy. Both individual and corporate decisions are, in fact, a blend of economic and behavioral forces. The latter include varying levels of conservatism, enthusiasm, risk taking, time expectations for returns on an investment, etc. The primary research instrument was 21 decision analysis panel meetings held with groups of TDS segment members and with potential user groups in four regions: the far west, southeast, middle Atlantic, and northeast. Data were analyzed by content and thematic analyses. The TDS is conceived as a series of functions leading to the end product of a functioning solar HVAC system or service. A chart in the text displays the various functions and their working relationships. This study focused on the major and permanent TDS functions -- financing, manufacturing, distributing, building, and installing -- as well as on commercial and private residence consumers. This summary presents a broad overview of the behavioral/economic barriers to solar acceptance; a brief review of how these vary within each TDS and consumer segment studies; and a precis of legislative and programmatic recommendations for federal, state, and local government action.

ST78 11160 Hybrid Solar-Electric Service ConceptAimone, M.A.
Jrnl: Mil. Engng., V 70:17-19, N453, 1978

A solar-electric demonstration project, authorized by the Solar Energy Research, Development, and Demonstration Act of 1974, will cooperate with engineers, architects, and industry to design and demonstrate equipment for home solar heating and a service utility system capable of stimulating the residential market. Individual components of the system are described and considered to be reliable, only lacking in service support. Numerous questions posed over how the sun is to be managed and sold have been evaluated by an Electric Power Research Institute (EPRI) computer simulation, which calculated electrical energy savings under different solar design parameters. An energy mix of 60 percent solar and 40 percent electric was estimated in the Florida-based study. Two areas of potential impact are identified in (1) large-scale temperature control of new buildings, and (2) development of a residential hybrid solar-electric utility.

ST78 11161 Residential Solar Heating in UzbekistanAksenov, L.F.; Viron, I.Y.; Avezov, R.R.; Shvaleva, O.L.; Gafurov, A.M.
Uzb. SSR Sci. Res. Inst. for Civil Engng., Uzbek SSR
Jrnl: Applied Solar Energy, USSR, Engl. Transl., V 13:50-52, N2, 1977

The basic arrangement for solar heating, cooling, and hot water supply in Tashkent buildings is described; the example considered is an experimental 32-apartment building with solar heating and hot water supply, designed by the Uzbek Scientific Research Institute for Civil Engineering with the participation of the Physicotechnical Institute of the Academy of Sciences of the Uzbek SSR.

ST78 11162 Obstacles to the Development of Solar EnergyAnderson, B.
Jrnl: Solar Age, V 1:25-29, N4, April 1976

The many barriers to the use of solar energy may be divided into three areas: the general ignorance of the subject in America, the scarcity of equipment, and the high

initial costs of solar systems. People find it difficult to accept solar energy as a means of reducing drains on other fuels, but think of it as a total alternative. Solar energy as the only source of heating needs must wait for technological advances and cost reduction to become practical. However, with the increasing prices of other fuel sources, solar energy is fast becoming viable as an adjunct energy source. High initial costs for these systems could be mitigated by tax revisions, low-interest loans, and some kind of tax write-off to offset this investment. Reasonable mass-use systems depend upon collectors and storage systems which perform well for many years and are price competitive. The development of mass produced systems also depends upon a viable market for them. This see-saw situation must be resolved. The diversity of the construction industry inhibits many manufacturers from producing solar systems. In spite of labor costs, on-site construction may be a viable alternative to self-installation. A lack of architectural engineers capable of dealing with solar systems is also a problem. With over 30,000 building code authorities in the nation and no overall regulating agency, solar systems are at a disadvantage in practical application. The government has at its disposal many means of assisting manufacturers and consumers in the development and use of solar energy systems by providing examples and incentives.

ST78 11163 Solar Energy Utilization in 1977; Status, Results, Prospects

Ante, B.

Battelle-Institut, Frankfurt Am Main, W. Germany

"Heating with the Sun II," March 3,4, 1977 Munich, W. Germany

Avail:AIAA, A78-28577 Jnl: Proc. of Mtg., V 2, Deutsche Gesellschaft Fuer Sonnenenergie, p. 3-28, In German

The article opens with a brief review of current and new (fusion, and direct and indirect solar energy) energy technology in the context of energy crisis and energy policy. Consideration is then given to the state of the art and the state of innovation in solar energy technology with attention paid to the potential for the widespread practical utilization of solar energy, and to the worldwide distribution and marketing of solar energy installations, and in particular, solar houses. The future market for one and two-family solar houses is discussed. The extent to which solar energy can alleviate world energy problems is considered.

ST78 11164 The Fraction of Solar Energy Available for Direct Conversion Processes

Archer, M.D.

Cambridge Univ., Cambridge, England

Avail:AIAA, A78-28168 Jnl: Solar Energy, V 20:167-169, N2 1978

The amount of solar energy which can actually be used by a photovoltaic converter to do useful work depends on a given threshold value. This value is a function of both the design characteristics of the converter and of ambient atmospheric conditions. Below the threshold value, photons are absorbed and cannot do work. This paper evaluates atmospheric variables and converter parameters in an effort to determine photon threshold values under different conditions.

ST78 11165 Direct Utilization of Solar Energy With the Aid of Low-Temperature Heating

Bach, H.

Stuttgart, Universitaet, Stuttgart, W. Germany

"Heating With the Sun II," March 3,4, 1977 Munich, W. Germany

Avail:AIAA, A78-28591 Jnl: Proc. of Mtg., Rept., V 2:271-280, Deutsche Gesellschaft Fuer Sonnenenergie, Munich, W. Germany

Direct solar heating of houses precludes the use of any energy sources but the sun, as well as the use of heat pumps to raise the temperature of the heat-transfer fluid. The major components of the system, used here for low-temperature heating, are a solar collector array, a heat-storage unit, and the working fluid. In designing a low-temperature heating solar house, consideration is given to month-by-month yearly heat requirements and to the optimal type of solar collector.

ST78 11166 Water Requirements for Solar Energy

Backus, C.E.; Brown, M.L.

Arizona State Univ., Tempe, AZ

Jnl: J. Am. Water Works Assoc., V 68:366-369, July 1976

Of the many proposed applications for direct use of solar energy, electric power generation is the one expected to require the largest amounts of water. The two types of power plants, thermal and photovoltaic, differ considerably in their water requirements; some thermal plants utilize significant amounts of water for cooling, while the photovoltaic plants require no water for this purpose. This interdependence of isolation and water availability must be a factor in determining the type of solar power plant that is feasible for a given area and the power production that can be expected.

ST78 11167 Assessment of Solar Heating and Cooling Technology

Balcomb, J.D.; Perry, J.E.Jr.
LASL, Los Alamos, NM
Avail:NTIS, N78-19667

In order to assess in detail the state of the technology for solar heating and cooling of buildings, five two-day meetings were held. The meeting subjects were solar collectors, thermal storage, air conditioning and heat pumps, systems and controls, and non-engineering aspects of solar energy. A condensation of these meetings is offered, presenting for each topic discussed the details of the state of the art, the problem areas, and the objectives of necessary research and development. The existing state of technology for solar heating and cooling presents a mixed picture. Liquid heating flat-plate solar collectors, for example, are in a rather mature stage, and there is a small viable industry producing components. Even here, however, there are problems of materials which, if solved, can reduce collector cost, improve performance, or increase lifetime.

ST78 11168 Public Policy Issues; A Southern California Gas Company Project SAGE Report

Barbieri, R.; Hirsberg, A.S.
JPL, California Inst. of Tech., Pasadena, CA
Avail:NTIS, N78-19613

The use of solar energy to stretch our supplies of fossil fuels was investigated. Project SAGE (semi-automated ground environment) addresses itself to one application of this goal, solar assistance in central water heating systems for multi-family projects. Public policy issues that affect the rate of adoption of solar energy systems were investigated and policy actions were offered to accelerate the adoption of SAGE and other solar energy systems.

ST78 11169 Florida Solar Energy Equipment and Services

Beatty, K.D.; Talwar, R.
Florida Solar Energy Center, Cape Canaveral, FL, Energy Systems Analysis Div.
Avail:NTIS, NP-22148 Nov. 1976

This document is intended to serve as a source of basic information on solar energy equipment available from manufacturers, distributors, and retailers in Florida and on solar energy related engineering and design services offered in the state. The directory is designed for use by architects, engineers, and others seeking information on available solar energy equipment. The product descriptions provide key information about solar energy products, with the recognition that additional detailed product specifications can be obtained from the individual companies. The information provided is sufficient, however, to allow those selecting solar energy equipment to identify products which may meet their requirements. The solar energy equipment listed is limited to that in production and commercially available or in advanced development and near the production stage. It includes equipment specifically designed to use solar radiation for application in domestic water heating, pool heating, and heating and cooling of buildings. For example, descriptions of those components of solar energy systems which are not unique to solar energy utilization. For example, descriptions of circulating pumps are not included. Such products normally are listed in other more extensive product catalogs, but names of conventional products are given when available. Exceptions to this rule have been made for storage tanks because they represent a major subsystem of the solar energy system. The directory also lists companies with experience in design of solar energy systems or which offer services specific to solar energy utilization. Included are companies with experience in engineering design of systems and testing of solar energy equipment. While efforts were made to avoid omitting firms providing legitimate solar energy design and test services, the listing does not represent as thorough an effort as was made for the manufacturers and distributors of equipment.

ST78 1117 0 Solar Option

Bell, C.R.; Jager, F.

Jrnl: Options, (IIASA), p. 1-4 Summer 1977

The International Institute for Applied Systems Analysis reviews the costs and benefits of the solar energy options to see where they can realistically be applied. Climate is basic to the efficiency and cost of solar energy, with direct radiation more useful than indirect radiation. An outline of solar technology includes the use of heliostats, photovoltaic arrays, and solar-thermal-electric concepts (STEC) and their market feasibility. The report concludes that high capital costs and the vast amount of land needed to collect solar radiation will make it non-competitive for power generation capital. Small-scale and residential applications, however, could become competitive as fuel prices rise. In regions requiring large amounts of low-grade heat, a solar economy could result in disruptive shifts of materials and manpower. Market sensitivity analyses indicate that a faster breakeven point, lower capital requirements, improved system efficiency, and a program of government subsidy are needed to take the solar option beyond test programs to widespread implementation.

ST78 1117 1 Solar Energy Can be Self-Supporting Long-Term Energy Storage

Benseman, R.F.

Dept. of Sci. and Indust. Res., Gracefield, New Zealand

Jrnl: NZ Energy J., V 50:17-18, N2 Feb. 1977

A scheme is outlined for economic solar energy storage based upon combining the solar energy collected by up to 100 houses into a single long-term (full season) energy storage system. The storage of solar energy by sensible and latent heat storage are briefly compared. Solar heating factor and system utilization factor are briefly explained as the significant economic comparison parameters for energy storage sizing. A sample calculation of the economics of large-scale long-term solar energy storage for 100 houses is presented. Other benefits of this energy storage scheme are listed.

ST78 1117 2 San Francisco Bay Area Solar Heating Guide and Directory

Bereny, J.A.; Carroll, J.

Solar Energy Information Services, San Mateo, CA 1977 \$5.95

The following topics are discussed: the collection of solar energy, solar heating applications, economics of solar heating, and solar heating information resources. Included in the appendices are a product and service directory and an address and telephone directory.

ST78 1117 3 Commercial Applications of Solar Total Energy Systems

Boobar, M.G.; McFarland, B.L.; Nalbandian, S.J., Smith, K.E.

Rockwell Int. Corp., Canoga Park, CA

12th IECE Conf., 1977

Jrnl: Proc. of Conf., V 2 Am. Nuclear Soc., Inc., La Grange Park, IL

A methodology has been developed by Atomics International under contract to the Energy Research and Development Administration to define the applicability of solar total energy systems (STES) to the commercial sector (e.g., retail stores, shopping centers, offices, etc.) in the United States. Candidate STES concepts were selected to provide on-site power generation capability, as well as thermal energy for both heating and cooling applications. Each concept was evaluated on the basis of its cost effectiveness (i.e., as compared to other concepts) and its ability to ultimately penetrate and capture a significant segment of this market, thereby resulting in a saving of fossil fuel resources. The photovoltaic STES appears favorable for applications under 800 kwe, whereas the organic rankine STES would be more cost-effective for larger energy demand applications. Initial penetration of these systems are expected to occur in the northeast for large shopping centers in the 1985 to 1995 time period.

ST78 1117 4 Solar Energy: Perspective and Prospects

Bos, P.B.

EPRI, Palo Alto, CA

Jrnl: Proc. Am. Power Conf., V 38:447-457, 1976

With solar energy promising to supplement the nation's energy resources, its prospects are reviewed. The federal government through NSF and subsequently through ERDA, has been

supporting solar research. Also, the utility industry has been supporting research through EPRI. The program at EPRI is summarized briefly. Technology reviews and assessments of solar heating and cooling, solar electric power generation, wind energy conversion, ocean thermal energy conversion, photosynthesis of biomass, and environmental impacts are included. It is concluded that large-scale utilization of solar applications for electric power production is not anticipated before the year 2000. Competitive energy costs must be demonstrated, requiring major cost reductions in collectors, reflectors, or photovoltaic arrays, as well as long system lifetimes of 15 to 30 years. Solar energy systems must be assessed under the same conditions of reliability as conventional power systems.

ST78 11175 Technical Safety Questions Concerning Solar Energy Installations

Breuer, K.

Zentralverband Sanitaer, Heizung und Klimatechnik, Bonn, W. Germany

"Heating With the Sun II," March 3,4, 1977 Munich, W. Germany

Avail:AIAA, A78-28593 Jnl: Proc. of Mtg., Rept., V 2:303-318 In German

Deutsche Gesellschaft Fuer Sonnenenergie, Munich, W. Germany

Fire and water pressure regulations relevant to solar energy installations are examined in the framework of a discussion of solar installation safety. Solar energy installations are contrasted with roof heating systems. Topics considered include the pipe system, heat exchange system, temperature control, and means of preventing excessive water pressure. It is suggested that components should be tested with regard to their operation in unified systems.

ST78 11176 Solar Energy: Its Conversion and Utilization

Farber, E.A.

Univ. of Florida, Gainesville, FL

Canaveral Council of Tech. Societies, Canaveral, FL

14th SCSTFBL Conf., 1977 Jnl: Proc. of Conf.

The needs, status, and potential of solar energy are presented and the various applications are put into proper perspective. The fact is emphasized that all energy sources are needed to solve the energy problems and the ones should be used which can do the job best. It is also pointed out that one must learn to live off energy income instead of savings and with solar energy, the only large inexhaustible income, the choice is limited.

ST78 11177 Public Utility and Solar Energy Interface: An Assessment of Policy Options: Executive Summary, Final Report

Feldman, S.L.; Anderson, B.

Clark Univ., Worcester, MA

Avail:NTIS, DSE/2523-1 Dec. 31, 1976

Existing research and on-going activity in the interface between the public utility industry and solar energy systems for buildings are reviewed and assessed. The state-of-the-art is presented as both an exhaustive comparison of studies to date concerning methods of evaluating the performance of solar buildings in the interface, and present state legislation in solar demonstration and research projects. Major technology configuration of the interface include solar building design, utility control of auxiliary energy through telemetry, and utility energy storage. A section on market penetration includes a literature review and critique, a discussion of utility pricing on solar building design, a scenario of the timing of solar building impact on utilities, and policy implications of utility ownership. The results of initial surveys of utility manager perceptions and consumer attitudes are presented. A discussion of various public policies affecting the interface and their impact is given.

ST78 11178 Utility Alternatives for Solar Energy

Freeman, J.K.

Energy Conservation Investments, Inc., Washington, D.C.

Jnl: Publ. Util. Fortn., V 101:20-23, N1, Jan. 5, 1978

Arguments associated with the utility industry's role and responsibility in developing solar energy are presented. Issues surrounding public utility involvement include developing full public policy support and differentiating between centralized and dispersed systems of solar power generation. Utilities are able to muster both the personnel and financial resources to develop and evaluate the technology to deal with the

climatic, wind, cost, and other factors affecting centralized utility services. There are more complex issues, however, in the case of dispersed systems because each system has its own demand patterns and a unique set of administration and consumer relationships that complicate rate setting. When individual customers install solar equipment that meshes with the utility, they are introducing unregulated energy into a regulated system. Four strategies are outlined that range from no connection between the utility and the solar equipment to all equipment treated as part of the utility. Billing for these strategies would range from straight metering to customer charges based on BTU's consumed. A rate-base approach entails several major regulatory and legal issues, including state and federal utility statutes, federal antitrust laws, and financing and depreciation procedures.

ST78 11179 When, Not If, is Now Key to Solar Power

Gilmore, C.P.

Jrnl: Sci. Digest, Chicago, V 81:42-45, N3 1977

There were thousands of solar water heaters in Florida and the southwest in the 1920's. Gas discoveries ended solar hot water use in the United States, although it continued its growth in Australia and Israel. Today solar energy converted to electricity is considered too expensive but may be feasible in the late 1980's. Today, in the United States, the emphasis is towards large-scale use of solar energy for electricity. Solar cells commonly used on every spacecraft for a decade are currently too expensive for utility use. Predictions are that the cost of solar electricity will reduce to 50 or 30 cents a kilowatt by 1980. The other major solar effort is the return of solar water heaters. Another project for large-scale use involves a steam turbine engine to generate electricity. The Energy Research and Development Administration hopes to have such a plant operable by 1980. Fortune magazine is quoted as saying that if solar costs are lowered, solar energy may become the largest economic move since the automobile.

ST78 11180 Solar Energy Research: Making Solar After the Nuclear Model

Hammond, A.L.; Metz, W.D.

Jrnl: Prof. Engng., Washington, D.C., V 47:24-30, N9, Sept. 1977

After five years of rapid but uneven development, solar energy is in need of reassessment. The present federal program has been as much the product of institutional happenstance and various technical predilections as it has been the product of coherent planning. Many solar technologies already work even though the best designs have not yet been found, and they are already facing the economic challenges that other long-range options have yet to confront. It is arguably time to reconsider solar priorities and ask whether the distribution of research resources among nuclear, fossil, and solar options reflects a rational policy.

ST78 11181 Home Energy How-To

Hand, A.J.

Harper and Row, New York, NY 1977 \$9.95

This is a complete guide to saving and producing home energy. Ways are summarized to cut home operating costs; conserve fossil fuels; reduce pollution; and heat, cool, and power the home. The book is divided into two parts. Part I deals with ways to conserve energy. Part II concentrates on ways to harness the energies of sun, wind, water, and biofuels -- and heat with wood. Part I begins with thoughts on eliminating waste. Means are described to keep warm and cool air where you want them. Practical concerns include insulation, caulking, weatherstripping, windows, doors, landscaping, and house design. The author explains how to evaluate materials, cost, and payback times, and provides clearly illustrated step-by-step instructions for handling nearly all of the tasks yourself. Maintenance of furnaces and air conditioning systems is described. Part II tells how to produce energy with solar collectors, wind and water generators, biofuel plants, and wood burners. The author explains the principles of the best hot-air and hot-water systems and then tells how to determine which would work well. Over 200 easy-to-follow illustrations and the latest in methods and materials are included.

ST78 11182 The Diffusion of the Use of New Energy Technology as a Context for an Overview of Solar Energy Technologies

Hirshberg, A.S.

JPL, California Inst. of Tech., Pasadena, CA

Avail:NTIS, N78-19611

The process by which new solutions to the energy dilemma are generated and used as a context for an overview of solar energy economics and technologies.

ST78 11183 Environmental and Safety Implications of Solar Technologies

Holmes, J.G.; Baluss, J.E.; Muhlmester, P.E.; Miller, S.G.; Super, T.L.; Thomasian, J.B.
Energy and Environ. Analysis, Inc., Arlington, VA
Annual ASISES Mtg., 1977
Jrnl: Proc. of Mtg., V 1, Secs. 26-38

A summary of an eight-volume series of environmental reviews (ERDA-77-47/1-8) prepared for the environmental and resource assessments branch of ERDA's Division of Solar Energy and Environmental Analysis, Inc., of Arlington, Virginia, is presented. The series analyzed the wide range of environmental impacts expected to occur through the implementation of the eight solar technologies currently being funded by ERDA: heating/cooling, solar thermal electric, total energy systems, industrial/agricultural applications, photovoltaics, wind, ocean thermal energy conversion, and fuels from biomass.

ST78 11184 Solar Energy Commercialization at the State Level: The Florida Solar Energy Water Heater Program

Johnson, M.; Tiedemann, T.F.
Florida Solar Energy Center, Cape Canaveral, FL
Avail:NTIS, PB-270158 March 1977

A detailed study was made of current problems associated with the introduction and commercialization of solar technologies in the state of Florida, particularly domestic water heating. Solar energy related legislation considered by state legislatures is analyzed with emphasis on actions recommended to accelerate commercialization and use. The study presents proposed standards and programs consistent with suggested comprehensive Florida solar energy commercialization plans. The use of solar water heaters in state buildings as a potential incentive to a local solar energy industry is briefly examined. Included are detailed instructions for constructing a model solar water heater, directed primarily at high school students; and climatological data.

ST78 11185 Solar Energy in Israel

Konigsberg, A.S.
State Univ. College, New Paltz, NY
Jrnl: Alt. Energy Sources, V 22:13,15 Sept. 1976

Emphasis in Israel has been on low-technology decentralized systems and on agricultural applications. Use of solar water heating systems is discussed. Projects of the Ministry of Agriculture, the Israel Institute of Technology (Technion), and other academic and industrial researchers are mentioned briefly. The Technion "radiation trap" is described briefly.

ST78 11186 Solar Energy in Australia

Morse, R.N.
Commonwealth Sci. and Industrial Res. Org., Melbourne, Australia
Jrnl: Ambio, V 6:209-215 N4 1977

Solar energy could make a major contribution to Australia's primary energy supply by the year 2000 by providing some of the heat used in homes and industrial processes. Half the country's energy usage is in the form of heat which is the most cost-effective way of utilizing solar energy. There is also a possibility of providing a renewable liquid fuel from the cellulose which is produced by photosynthesis in trees and plants. Solar electric power generation is likely to be restricted to small installations since Australia's large coal reserves can supply power stations for the foreseeable future.

ST78 11187 Lifestyle Implications of Decentralized Solar Energy

Okagaki, A.
Center for Sci. in Public Interest, Washington, D.C.
Jrnl: Energy Use Mgmt., V 2, 1977 Pergamon Press, Inc., Elmsford, NY

Decentralized applications of solar technologies can be integrated into community structures and lifestyles that are radically different than the conventional American lifestyle. It is argued that for environmental and sociological reasons it would be wise to explore alternative communities and lifestyles based on "appropriate" or "intermediate" technologies such as decentralized solar power. A federal program to support this kind of exploration is proposed.

ST78 11188 Solar Heating and Cooling, Recent Advances

Paul, J.K.
Noyes Data Corp., Park Ridge, NJ 1977

The US patent literature on solar heating and cooling since 1970 is covered in the following chapters: Flat-Plate Collectors, Focusing Collectors, Upright Collectors, Other Collectors, Coatings, Storage Devices, Heating and Cooling Systems, Domestic Hot Water Systems, and Swimming Pool Applications. The material is indexed by subject, company, inventor, and patent number.

ST78 11189 Solar Energy Engineering Book

Sayigh, A.A.M.
Riyadh Univ., Riyadh, Saudi Arabia
Avail:AIAA, A78-27852 Academic Press, Inc., New York, NY 525 p. 1977

The total and spectral solar irradiance is considered along with a solar energy availability prediction from climatological data, heat transfer for solar energy utilization, liquid flat-plate collectors, convective heat-transfer effects within honeycomb structures for flat-plate solar collectors, solar air heaters and their applications, concentrating collectors, a solar pond, and solar furnaces. Attention is also given to photovoltaic conversion, an application of solar energy in space, the conversion of solar energy into electricity, the storage of solar energy, refrigeration and air conditioning, solar heating and cooling of homes, the solar production of hydrogen, solar energy measuring equipment, the fundamentals of water desalination, and questions regarding the economics of solar energy.

ST78 11190 Solar Progress Down Under: Solar Energy Research in Australia

Scholes, W.
Avail:AIAA, A78-28199 Jrnl: Machine Design, V 50:26,30,32,35 March 9, 1978

Advances in solar energy research in Australia are briefly reviewed. Design concepts of effective solar energy systems are discussed including a system which would store enough solar energy by chemical means to supply a city of 600,000 inhabitants. Attention is given to the commercial development of efficient water heaters, the design of better solar collectors, a solar power steam engine, kilns and stills for drinking water, and solar cells.

ST78 11191 Simple Solar Technology for Applications in Rural Areas

Schulz, H.
Avail:AIAA, A78-30321 Jrnl: Sonnenenergie, V 3:8-10,12-14, 17 Jan.-Feb. 1978
In German

Solar technology on a small scale, especially for space and water heating, can be particularly cost-effective in rural areas. The paper compares various methods of solar collection and storage, e.g., air and water media, with heat transfer effected by water tubes, in terms of their usefulness either alone or in conjunction with wind-generated electricity, and fuel generation by biomass. Heating requirements are assessed as a function of climate and local energy requirements. Finally, schematics of model collection systems are presented.

ST78 11192 Design for a Limited Planet

Skurka, N.; Naar, J.
Ballantine Books, New York, NY 1976 \$5.95

The book includes a brief history of solar energy but its main emphasis is the solar dwelling designs. Thirty-seven buildings are reviewed, including a few solar energy institutes and experimental buildings. The book covers greenhouse design, wind generation, electric generation, and environmental design. Both passive and active solar system designs are included in the text. A list of solar manufacturers, wind equipment manufacturers, and a glossary of solar terms are included in the text of the book. New buildings as well as renovated structures are included in the building design review. The book lists individuals familiar with solar energy through construction of their own home as well as that of others and other people considered as pioneers in the field of solar energy.

ST78 11193 Solar Energy Research in the European Economic Community

Strub, A.

Kommission der Europaeischen Gemeinschaften, Brussels, Belgium

"Heating With the Sun II," March 3,4, 1977 Munich, W. Germany

Avail:AIAA, A78-28578 Jnl: Proc. of Mtg., V 2:29-41 Deutsche Gesellschaft Fuer Sonnenenergie, Munich, W. Germany In German

A review is presented of EEC energy policy with regard to R and D in the field of solar energy. Brief descriptions are given of the following projects: flat-plate collectors and their application in buildings, solar thermal power plants, photoelectric conversion, photochemical and photosynthetic processes, bioconversion, and the collection of insolation data. The organization and management of the EEC solar R and D program are described.

ST78 11194 Utilities Put the Sun to Work

Taylor, R.

EPRI, Palo Alto, CA

Avail:AIAA, A78-30744 Jnl: EPRI J., V 3:26-32, March 1978

A description is presented of investigations regarding the use of solar collectors in North Dakota. The described project is one of 458 active projects which were compiled during the summer of 1977 to determine the extent of solar energy research sponsored by electric utilities throughout the country. A substantial majority of the solar research projects deal with solar heating and cooling or related research. The survey also identified 34 wind projects, 28 projects dealing with solar data collection, approaches for reducing the cost of wind energy, the testing of a collector system, a house constructed for obtaining solar energy information, a solar space conditioning system, the integration of solar electric systems, the utilization of solar heat in the cloudy northwest, and a study of the performance of 20 solar homes in northern California.

ST78 11195 Solar Energy Use in Austria, State of the Art, Development and Application, Already More Than 500 Plants in Operation

Urbanek, A.

Jnl: Mitteilungsbl. Dtsch. Ges. Sonnenenergie, V 2:13-23, N6 Nov. 1977 In German

The article presents a survey of solar energy utilization activities in Austria. Up to the end of 1976, there were about 100 solar plants for water, swimming pool, and space heating in operation in Austria. By the end of 1977 it might be some 500. Details of promoted research programs and of research institutes are supplemented by a number of plants already in operation. Meteorological data for Austria are presented.

ST78 11196 5000 People Participated in the Conference on "Solar Heating II," DGS Organized the Biggest European Solar Meeting and Exhibition in Munich

Urbanek, A.

Jnl: Mitteilungsbl. Dtsch. Ges. Sonnenenergie, Summary of Mtg., V 2:31-35, N2 March 1977 In German

We are dealing with a summarizing report on the Conference of the German Association for Solar Energy on "Solar Heating II - Practical Domestic Technology," which took place on the third and fourth of March 1977 in Munich. An exhibition was associated with the conference at which more than 50 firms from West Germany, Austria, and Switzerland exhibited products for solar energy technology. The lectures at the conference were concerned with technological problems of collector equipment, architectural, legal, and safety questions associated with the nature of solar energy. Review lectures gave an impression of the state of solar technology, the market position for solar plants, and the research and development program of the European community in this field.

ST78 11197 Uses and Prospects of Solar Energy; Second Revised and Enlarged Edition

Vaillant, J.R.

Paris, Eyrolles, Editeur, 502 p. 1978

Avail:AIAA, A78-31068 In French

Procedures for collecting and converting solar energy are discussed with attention to characteristics of solar radiation, solar units for generating energy, and the production of algae and hydrogen as means of 'storing' solar energy. Several applications are examined; topics include domestic household uses, economic considerations, solar energy architecture, and the use of solar energy in urban and rural areas. Factors affecting the future extent of use of solar energy are considered.

ST78 11198 Florida Solar Energy Industry

Yarosh, M.M.; Beaty, K.D.; Talwar, R.

Florida Solar Energy Center, Cape Canaveral, FL

Annual Mtg. of ASISES, 1977

Jrnl: Proc. of Mtg., V 1, Secs. 26-38, Int. Solar Energy Soc., Cape Canaveral, FL

In 1974 the Florida legislature established the Florida Solar Energy Center to carry out activities which would further the application and utilization of solar energy in Florida and in the nation. It was recognized that to carry out the specific mandates of the legislation, an indepth understanding of the status of solar energy in Florida and in particular, of the fledgling solar energy industry was essential. Accordingly, a study was conducted of business and industrial activities in solar energy within Florida, and because it was recognized that such information would be of use in furthering the application of solar products, the decision was made to publish a directory of solar energy equipment and services available in the state. The study has now been completed and the directory published and widely distributed.

ST78 11199 Retrofit: A Major Solar Opportunity

Yellott, J.I.

Arizona State Univ., Tucson, AZ

Jrnl: Solar Age, V 2:18-23, N3, March 1977

Growth projections in market opportunities for retrofitting solar energy systems are briefly discussed. Increases in energy demand and cost stimulate an increasing fraction of a total of 68 million single-family units to be retrofitted with solar heating/cooling and hot water systems. Sources of information on regional long-term insolation are given. A brief description of system options, including heat storage and distribution, and standby energy sources is presented. Rules of thumb for estimation of heating loads are presented. It is concluded that retrofitting of solar energy systems will accelerate over the next decade, and it is indicated that ingenuity will continue to be a key in the economics of retrofitting.

12,000 CONSERVATION

ST78 12104 How New England Life Squeezes BTU's

Anon.

Jrnl: Power, V 121:30-31, N10, Oct. 1977

The methods that have been effective in conserving energy at the New England Mutual Life Insurance Co. Building in Boston, Massachusetts, are described. They include: separate metering for heating and cooling, analysis of peak loads, rescheduling of A/C fans to reduce peak loads, rescheduling computer operations, reduction of building lighting to about one-half of what it was before, monitoring of lights at night and on weekends, maintenance efforts to reduce energy costs, and installation of a central computer to handle much of the work formerly done by operators.

ST78 12105 101 Ways to Cut Home Energy Costs--Right Now

Jrnl: Pop. Mech., V 148:117-120,123-124,126-128 N3 Sept. 1977

Energy conservation ideas for homeowners are included in this article. The first subgrouping includes things that do not need building or installation. Some of the energy conservation projects cover the following: water heaters, fireplaces, air conditioning, lighting, kitchen, laundry, and bathroom. A table explaining insulation and the R-values is also included. Weatherstripping, caulking, along with simple renovations are mentioned. Small energy control devices such as clock thermostats, automatic dampers, heat pumps, attic fans and storm windows are reviewed. Specific available products are mentioned in context to the energy saving devices.

ST78 12106 Sheet Metal Forming and Energy Conservation

Anon.

Am. Deep Drawing Res. Group

9th BCODDRG Mtg., Oct. 13-14, Ann Arbor, MI

Publ. by ASM, Metals Park, OH Proc. of Mtg., 284 p. 1976

Proceedings include 18 papers on the development and use of special sheet steels for automotive weight reduction and corrosion protection, the effect of the interaction between mechanical properties on material formability, the deformation theory of sheet metal formability, and the application of forming technology to production. Among the topics discussed are the use of high-strength cold-rolled sheet steels for automobile weight reduction, the use of hot-dip galvanized steel sheet for improved corrosion resistance, the effect of anisotropic plasticity and work hardening on sheet metal drawability, an anti-galling roughness profile which permits a reduction of the required amount of lubricant during the forming of steel sheets, a new plastic instability criterion for sheet metal forming applications, hydraulic bulge testing as an aid to formability assessment, the influence of strain-path changes on the formability of sheet steel, a theory of sheet metal bending in elastic tests, an evaluation of hole expansion tests on sheet steels, and the effect of the mechanical properties of sheet metals on the wrinkling behavior during deep drawing.

ST78 12107 US Energy Conservation Could Benefit from Experiences of Other Countries

General Accounting Office, Washington, D.C. Int. Div.

Avail:NTIS, N78-21619

Energy conservation policies and practices of four European countries are discussed. Information on those effective measures which seemed to be applicable to US efforts are noted.

ST78 12108 Development of Performance-Based Energy Conservation Standards for Buildings

Achenbach, P.R.; Heldenbrand, J.L.

NBS, Washington, D.C.

CBCEB, Oct. 25-27, 1976 Toronto, Canada

Jrnl: Proc. of Congr., p. 1-31 PB-274 975/2ST

NBS is assisting the Department of Housing and Urban Development and the Energy Research and Development Administration in developing performance standards for energy conservation in buildings. The NBS concept is based on overall energy use and life-cycle cost of a building, supplemented by performance requirements related to thermal comfort, visual environment, indoor air quality, durability, and health and safety considerations.

ST78 12109 Energy Saving Through the Correct Regulation of Heating, Ventilation, and Air Conditioning Units

Andreas, U.

Zentra Albert Buerkle K.G., Schoenaich, Germany, F.R.

Jrnl: Sanit. Heizungstech., V 41:237-241 N4 April 1976 In German

A main point in saving energy in the heating of buildings is the increased use of technical regulating devices. This article shows what is possible on this sector at today's technical level and what should already be considered in the planning stage. In particular, the transient heating operation (decreasing of temperature at night) lends itself to this purpose. However, it should be seen to that a pre-set, economical temperature is adhered to as exactly as possible during the operation period. The example shows that a temperature increase of 1 K means 5 to 7 percent more energy consumption. A further part of this work is dedicated to the different possibilities of technical regulation. The parameters which influence the extent of energy saving are discussed.

ST78 12110 Energy Conservation via Solar Energy Application to Multi-Family and Commercial Structures, Volume 2, Part 2, Solar Energy Atlas for New York State

Bailey, B.; Healey, J.; Stewart, R.

State Univ. of New York, Albany, NY

Avail:NTIS, N78-21618

The Part 2 supplement of the atlas updates and broadens scope information included in the original atlas. Pyranometer data collected throughout New York State through 1975 are presented. Included are data organized by monthly, daily, and hourly means. Annual and monthly distribution maps for solar radiation are included for the 1970-1975 period. A climatological section provides monthly and annual distribution maps for several climatic parameters.

ST78 12111 Conservation and the Contributions From Advanced Energy Source

Beall, S.E.Jr.

ORNL, Oak Ridge, TN

Avail:NTIS, N78-21648 FIECTAP, Aug. 2, 1977

Advanced energy sources being developed by ERDA are discussed along with contribution of 1 Q (quadrillion BTU) or less in 1985, and estimates perhaps optimistically that these new technologies can contribute as much as 25 Q of our energy needs by 2000 A.D.

ST78 12112 Energy Conservation and Lighting--The Facts and the Follies

Benya, J.R.; Webster, J.C.

Smith, Hinchman, and Grylls Assoc., Inc., Detroit, MI

Jrnl: Light Des. Appl., V 7:21-27 N9 Sept. 1977

Some follies of energy conservation in lighting are pointed out. Three methods often recommended to solve complex problems are criticized, in particular, the FEA/GSA regulations (50-30-10), the energy budgets, and the equivalent sphere illumination (ESI) calculators. It is argued that quality illumination cannot be mandated according to preconceived general principles. The lighting of each individual space should be determined by the visual tasks being performed in the space and their locations with respect to luminaires. Some design methodologies for quality illumination and energy conservation are presented.

ST78 12113 Energy Conservation in Solving Odor Problems

Boscak, V.; Kenson, R.; Bartlett, P.; Cha, S.

TRC-RES Corp. of New England, Wethersfield, CT

4th EEN Conf., Oct. 3-7, 1976 Cincinnati, OH

Jrnl: Proc. of Conf., Publ. by AIChE, Dayton Sect., New York, NY p. 98-116 1976

The use of innovative engineering as well as good problem definition studies can significantly decrease the operating/energy costs of odor control and in many cases also the capital cost. Examples of such studies for an automotive plant, a rubber plant, and a sewage treatment plant show how this can be done. Another problem in odor control is how to minimize the operating/energy costs of present control systems, especially incinerators. A plan of action is outlined of how to approach this problem by examining: the actual degree of odor control required; process operation changes to minimize odors; modifications to control hardware to improve energy/operating costs. This plan of action is illustrated in case histories concerning a rendering plant and a surface coating process.

ST78 12114 Case Against Private Utility Involvement in Solar/Insulation Programs

Bossong, K.
Center for Sci. in Public Interest, Washington, D.C.
NP-22400 June 8, 1977

The arguments against private utility involvement are arranged under the following headings: excessive profit-taking, monopolization/favoritism, increased cost to consumers, homeowners would pay twice, the lack of accountability, the lack of commitment to solar by utilities, solar-political-ethical considerations, solar-conservation technologies are inherently decentralized, and the other alternatives.

ST78 12115 Improved Systems for Energy Conversion and Conservation as Pollution Control Alternatives: USEPA Program

Bostian, H.E.; Skovronek, H.S.; Mournighan, R.E.
EPA, Cincinnati, OH
12th IECE Conf., 1977
Jrnl: Proc. of Conf., V 1, Am. Nuclear Society, Inc., La Grange Park, IL

This paper is an overview of a USEPA research program on energy conversion and conservation. The program emphasis is on environmental problems or benefits of more efficient energy systems or ones using more abundant domestic energy resources. More efficient energy systems can generally be considered as environmentally attractive alternatives but their relative environmental-economic benefits need to be determined. On the other hand, some systems could have unique pollution control problems because of different operating conditions, use of higher sulfur fuels and feedstocks, or possible generation of hazardous pollutants. The program coverage includes the environmental aspects of waste energy utilization and other energy conservation measures, advanced power systems such as magnetohydrodynamics (MHD), ones using high-temperature turbines, and solar and geothermal energy conversion.

ST78 12116 Energy Conservation in Buildings

Brundrett, G.W.; Leach, S.J.; Parkinson, M.J.; Pickup, G.A.; Rees, N.T.
Jrnl: Coal Energy Q., V 14:19-30, 1977

After briefly discussing the UK energy consumption in dwellings, the article focuses on the measures which could lead to considerable energy savings in both old and new buildings. Current research on some of these measures is described with emphasis on (1) the design of low-energy housing by increased insulation and improved services, and (2) increased efficiency of heating applications. In addition, current research on ventilation is briefly reviewed.

ST78 12117 Energy Conservation and Energy Source Substitution in Old Buildings--Estimation of Cost and Efficacy--Solar Energy Utilization

Brunner, C.U.
"Heating With the Sun II," March 3,4, 1977 West Germany, Munich
Avail:AIAA, A78-28596 Jrnl: Proc. of Mtg., V 2:357-376, Deutsche Gesellschaft Fuer Sonnenenergie, Munich, W. Germany

The use of the ratio of the number of users to surface area to evaluate the feasibility of utilizing solar energy for either room heating or water heating is analyzed and the problem of minimizing the use temperature is discussed. Difficulties associated with the use of solar energy systems in already existing buildings are examined. The cost and efficacy of solar energy is considered in comparison with fossil fuels and with respect to the level of service to be provided to units in old apartment houses.

ST78 12118 Energy Conservation Policy -- Opportunities and Associated Impacts, Study Module 1-A, Volume 1, Summary Report, Final Report

Butcher, W.R.; Hinman, G.W.
Washington State Univ., Pullman, WA
Avail:NTIS, N78-19661

A number of conservation measures that could significantly reduce growth in the Pacific Northwest's demand for energy are identified. If the 19 principal measures discussed are universally adopted, future energy demands will be reduced approximately 35 percent from the levels which can be anticipated without further conservation actions. Tables are included which show the capital recovery periods for investments in a number of conservation measures in selected cases assuming different rates for energy price increases.

ST78 12119 Areas of Regulatory Interest in Efficient Energy Use Research and Development

Cavagnero, W.J.

EPRI TCEUEE Workshop, 1976

EPRI-EM-313-SR Jrnl: Proc. of Workshop, V 1, Exec. Summary, V 2, Working Papers

Areas of special regulatory interest in efficient energy use, research, and development include: time of use metering; communications system related to measuring and controlling energy use; demand management and energy management systems; solar energy utilization; heating and cooling storage systems; and waste heat utilization. Activities of the National Association of Regulatory Utility Commissions in studying these subjects are described.

ST78 12120 Energy Conservation in the Home; An Energy Education-Conservation Curriculum Guide for Home Economics Teachers

Clinard, L.; Collins, N.

Univ. of Tennessee, Knoxville, TN, Environ. Center

Avail:NTIS, N78-21607

A guide designed for home economics teachers as a source of information, instructional materials, and suggested references about the energy situation as a whole, energy concepts, and the use of energy in the home is presented. Emphasis is placed on conservation measures applicable to the home.

ST78 12121 Energy Efficient Lighting--A Management Guide

Finn, J.F.

Jrnl: Light Des. Appl., V 7:18-20, N9, Sept. 1977

Twenty-eight points are listed to help managers lower the energy consumption of a lighting system. They include: appraisal of visual tasks, measurement of existing lighting levels, reduction of lighting levels to recommended levels, installation of lighting where necessary for seeing tasks, comparison of lamp efficacy, replacement of inefficient light sources, evaluation of reduced wattage lamps, evaluation of current lighting design data, comparison with more efficient luminaires, cleaning, checking reflectances, selective switching of perimeter lighting when daylighting is available, color coding of circuit breakers for different types of lighting, turning off lights when not in use, using energy equation to determine fuel savings, investigating costs of engineering advice, etc.

ST78 12122 Energy Conservation Via Solar Energy Applications to Multi-Family and Commercial Structures, Volume 3, An Energy, Engineering, and Economic Analysis of Heating and Cooling Systems for Multi-Family Structures

Fleming, W.S.; Bender, T.; Jagusztyn, T.; Parkman, P.; Sweetser, D.

State Univ. of New York, Albany, NY, Atm. Sci. Res. Center

Avail: NTIS, N78-21657 Spons. by NY State ERDA

An energy analysis was made for a multi-family apartment model involving the heating, cooling, lumination, and miscellaneous equipments energy consumption. The analysis compared various heating, ventilating, and air conditioning systems with and without solar assistance to determine their merits on the basis of energy conservation and economic value. An electric resistance heating and electric air conditioning system were utilized as the basis for system comparison. The building's orientation, U value and infiltration were also analyzed for consideration of architectural variables.

ST78 12123 Energy Conservation in Periodic Kiln Operations Using Thermal Energy Storage

Glenn, D.R.

IGT, Chicago, IL

Avail:NTIS, CONF-770416 1977

Periodic kilns were the backbone of the heavy clay (and other kiln-cured) products industries and are still commonly employed in many plants. In an ERDA-sponsored study, thermal energy storage (TES) conservation potentials were applied to periodic kilns. This study is reviewed and findings on current and projected energy demands and prices for kiln-using industries and the impacts when TES is integrated with the periodic kiln process flow are discussed.

ST78 12124 Energy Consumption and Conservation in School Buildings

Graham, M.P.

Carleton Board of Educ., Ottawa, Canada

Jrnl: Heat Piping Air Cond., V 49:85-90, N7 July 1977

The plan of action for the energy study is drawn up in detail. The concept of the plan is illustrated graphically, concise records of energy consumed were to be collated and evaluated, with the data reduced to consumption per unit of floor area and per unit of heating season (degree-day), so that an energy budget for a new school could be compared to the performance of existing facilities before approval. With the information reduced to units of kilowatt-hours per square meter per degree-day, the data provide a basis for computer analysis.

ST78 12125 A Report on the Development of a Model Energy Conservation Program for New York State Schools

Green, A.C.; Boice, J.R.; Burns, J.A.; Bedford, S.

Educ. Facilities Labs., Inc., New York, NY, ERDA

Avail:NTIS, PB-274 285/6ST 94 p. Nov. 23, 1977

All school buildings (158) in 22 of New York State's 730 school districts were analyzed in terms of energy use and conservation potential. This was done first with GAP2 (Guideline Analysis Program) adjusted to New York State's standards and then with CIP2 (Capital Improvements Program).

ST78 12126 Development and Application of Design Standards for Energy Conservation in Buildings

Heldenbrand, J.L.

NBS, Washington, D.C.

Jrnl: Ind. Forum, V 8:9-20, N3 Aug. 1977 PB-274 976/0ST

One-third of the energy consumed in the United States is used to heat and cool buildings and to provide illumination, water heating, and other building services. About 40 percent of this energy can be saved without reducing building performance. The first comprehensive and nationally applicable design standards for energy conservation in buildings have recently been developed and applied, and they offer the opportunity for substantial energy savings.

ST78 12127 Transportation Management and Energy Conservation

Hemphill, J.G.

FEA, Washington, D.C.

3rd EECTSN Conf., Aug. 2-6, 1976 Schenectady, NY

Avail:Supt. of DOC, GPO Jrnl: Proc. of Conf., CONF-760895

This paper summarizes the energy conservation impacts of various transportation management policies. The role of mass transit in alleviating the energy dilemma is discussed. It is concluded that a program package which incorporates incentives as well as disincentives is significantly more effective in reducing energy use than application of either alone. It is also emphasized that because of the low base for mass transit usage at the present time, there is not much potential for energy savings.

ST78 12128 Energy Conservation in the Meat Processing Industry, Phase I Report, June 1, 1976-December 31, 1976

Henrickson, R.L.; Ferguson, E.J.

Oklahoma State Univ., Stillwater, OK, ERDA

Avail:NTIS, ORO-5097-2 45 p. Dec. 31, 1976

Progress in studying the energy conservation potential of techniques for processing meat and of equipment for controlling the environment with meat processing facilities is reported. An energy consumption model is being developed and plant layout, materials handling methods, and work measurement have been studied.

ST78 12129 Home Improvements for Conservation and Solar Energy

Hickok, F.
Hour House, St. Petersburg, FL 1977

The initial chapter, Learning About Heat, explains the transfer of heat in houses, specifically to show how to cut down on heat loss or reduce fuel bills and to show how remodeling can be combined with heat loss reduction. Chapter 2, Being Your Own Engineer, is followed by chapters on attics, windows, doors, walls, floors and basements, and add-on rooms. The final chapters deal with solar heat and evaluating an old house.

ST78 12130 Guide to Demonstrations of Energy Conservation, Solar Energy and Other New Technologies: Energy Extension Service

Ignatius, N.
ERDA, Washington, D.C.
Avail:NTIS, TID-28044 Sept. 1977

This guide was compiled by the Energy Extension Service (EES) for use by state EES planners. It is intended to facilitate viewing of solar, conservation, and other energy technologies at work. The demonstrations listed in this guide have generally been limited to those most applicable to individual homeowners, small businesses, schools, and farms. In a few states, however, municipal systems have also been included. Many of these projects have received federal funding. The majority of projects demonstrate some form of solar energy. In addition to solar heating and cooling for homes and commercial buildings, a number of examples of farm applications such as solar crop drying are listed, as well as demonstrations of wind energy, biomass, photovoltaics, etc. Since all successful solar heating and cooling systems incorporate sensible energy conserving design, each solar heating and/or cooling project is at the same time an energy conservation project. When these conservation designs are of special interest or inventiveness, this has been noted. In a few cases projects demonstrate only conservation measures, such as the construction of buildings underground.

ST78 12131 Appropriate Technology and Energy Conservation: A Canadian Experience

McCloskey, B.
Univ. of Petroleum and Minerals, Dhahran, Saudi Arabia
Jrnl: Energy Use Mgmt., V 2, 1977 Pergamon Press, Inc., Elmsford, NY

Many developing societies still have, yet are rapidly losing, environmental attitudes and "technologies" that are appropriate to their context. Inherent in such attitudes, and particularly manifest in the siting and construction of indigenous habitats, is a strong feeling for energy conservation. The project described is an attempt, in part, to identify indigenous technologies and energy conserving building methods so as to develop, with modifications and additions, a form of housing appropriate to Indian reserves in northern Quebec.

ST78 12132 Energy Conservation in the Production of Hot Water

Miles, A.J.
BR. Gas Corp., England
Jrnl: Gas. Engng. Mgmt., V 17:210-216, N6, June 1977

Current emphasis on energy conservation, arising from increases in the cost of energy, has resulted in keen interest in the efficiency of heating and hot water installations. The author reviews the effects by British Gas Corp. to obtain reliable information on the efficiency of providing a domestic hot water service by some of the essentially traditional means available and presents the results of this investigation. The relative hot water efficiencies for gas and electricity are compared in terms of primary energy.

ST78 12133 Pollution From Agricultural Residues and the Energy Shortage; Two Birds, One Stone

Miller, K.A.
Stanford Res. Inst., Energy Center, Menlo Park, CA
4th Energy and Environ. Nat'l Conf., Oct. 3-7, 1976 Cincinnati, OH
Jrnl: Proc. of Conf., p. 219-225 Publ. by AIChE, Dayton Sect., New York, NY

In 1972 the Bureau of Mines projected that the usable energy content of agricultural residues could reach 2.5 million barrels per day of oil equivalent by 1980. Based on the implications of these figures, the field was investigated not just from an energy

standpoint but also from the realization that a good number of agricultural pollutants could be controlled at the same time. This paper principally addresses the economic feasibility of utilization of agricultural residues for energy. If utilization of residues for energy is feasible, agricultural pollutants can be controlled, at least to the extent that residues are used for energy production. Information gained from projects involving the production of energy from biomass form the basis for this paper.

ST78 12134 Design Guidelines for Energy Conserving Systems, Final Report

Qureshi, A.S.; Moeller, G.L.; Gore, E.
Baker (Michael), Jr., of New York, Inc., New York, NY
Avail:NTIS, PB-268989 March 1977

This report establishes design guidelines and design limitations for the selection, evaluation, and design of solar energy systems, total energy and selective energy systems, continuous duty standby systems, engine-driven chiller/heat pump systems, continuous duty standby systems, and solid waste boiler systems.

ST78 12135 Efficient Use of Energy in a Solar Building

Ucar, M.; Drucker, E.; Lagraff, J.
Syracuse Univ., Syracuse, NY
Jrnl: Energy Use Management, V 2 1977 Pergamon Press, Inc., Elmsford, NY

A generalized dynamic computer program (SYRSOL) was developed at Syracuse University under an ERDA grant for mathematical stimulation of the thermal behavior of multi-zone solar heated buildings. SYRSOL stands for Syracuse University Solar Building Energy Analysis Program. The system modeled employs a series of water-to-air heat pumps connected in a closed-loop flat-plate water-cooled solar collector, a water storage tank, and a coolant tower. Weather data are represented by sinusoids, which save programming and computing time. Many simulation runs were made with SYRSOL on a school and an office building in several cities.

13,000 ECONOMICS, LAW

ST78 13134 Forum on Solar Access

Nat'l Solar Heating and Cooling Information Center, Rockville, MD
 Avail:NTIS, N78-19607 Spons. in part by DOE, Proc. at New York, NY July 28, 1977

The forum on solar access was held to analyze various approaches to protecting access to sunlight. Presently, access to sunlight may be jeopardized by certain zoning regulations, architectural controls, and shade from structures and vegetation. The proceedings, as part of New York State legislation, should be of use to other state legislatures in developing policies on the subject of solar access.

ST78 13135 California Residential Energy Standards, Problems and Recommendations Relating to Implementation, Enforcement, Design

California State Dept. of Housing and Community Development, Sacramento, CA
 Avail:NTIS, N78-21640

Documents relevant to the development and implementation of the California energy insulation standards for new residential buildings were evaluated and a survey was conducted to determine problems encountered in the implementation, enforcement, and design aspects of the standards. The impact of the standards on enforcement agencies, designers, builders and developers, manufacturers and suppliers, consumers, and the building process in general is summarized. The impact on construction costs and energy savings varies considerably because of the wide variation in prior insulation practices and climatic conditions in California. The report concludes with a series of recommendations covering all levels of government and the building process.

ST78 13136 Incentives for Developing New Energy Sources

Committee on Finance, US Senate
 1st Session of 95th Congress, Hearings Before SubComm. on Energy and Foundations of the Committee on Finance June 20-21, 1977
 Avail:SOD, N78-21613

Testimony was given by all sectors of the energy community in an attempt to define the problems in energy production and to clarify the alternatives available with existing technology. Some of the energy technologies discussed were coal gasification, geothermal utilization, organic waste conversion, and solar energy. Various economic incentives were proposed to encourage energy exploration and development by industry.

ST78 13137 Energy and Economic Impacts of H.R. 13950 (Surface Mining Control and Reclamation Act of 1976)

ICF, Inc., Washington, D.C., Council on Environ. Quality, EPA
 Avail:NTIS, PB-274 632/9ST Sept. 1977 260 p.

Additional industry costs and such non-cost factors as restrictions, timing and implementation of provisions, and adaptability of mine operators to new regulations are analyzed. Representative surface mine types are identified to model the effects of geographic, topographic, and operating characteristics.

ST78 13138 Federal Incentives for Solar Homes: An Assessment of Program Options, Methodological Appendices

Regional and Urban Planning Implementation, Inc., Cambridge, MA, ERDA, Washington, D.C.
 Avail:NTIS, PB-274 654/3ST 573 p. Nov. 1977

This report contains the technical appendices for a study on the costs and impacts of potential federal incentives to accelerate the residential market for solar domestic hot water and/or space heating systems. It is divided into seven sections. They are: selection of incentives for detailed analysis; basic assumptions about solar feasibility in the residential sector; methodology for market impact analysis; summary of survey results; survey instruments; methodology for public cost analysis; and analytic review of solar market penetration studies and annotated bibliography.

ST78 13139 Proposal for a Regulation (EEC) of the Council on Granting Financial Assistance for Demonstration Projects on Energy Conservation, Information by the Federal Government

Heger/Bonn-Bad Godesberg, Germany, F.R. 1977 In German

Having adopted the aim to lower consumption growth rates within the communities through measures concerning the efficient use of energy and energy conservation, the Council of the EC now proposes to support undertakings within the EC. Meant is the application of energy-saving new equipment, methods or products on an industrial scale whereby each project has to present something novel which can serve as reference or impulse for the erection of further devices of its kind in the EC. The projects apply to heat pumps, heat utilization, combined production of heat and electricity, energy storage, rationalizing energy consumption in industry, and buildings with a low energy consumption. Furthermore, the council proposes the financial backing of projects for the utilization of alternative energy sources. These community undertakings refer to the making available of geothermal heat and the conversion of solid fuels into hydrocarbons.

ST78 13140 Simmering Solar Heating Market

Jrnl: Engng. News-Rec., V 11:20-24 1977

Natural gas shortages and high oil prices make solar energy an attractive alternative in the United States. On Capitol Hill the budget for solar programs jumped from \$50 million in 1975 to \$290 million in 1977. Congress is looking at tax breaks, loan and insurance programs to promote solar energy. Housing and Urban Development and ERDA have grant programs funding solar installations for approximately 1500 residential and 33 commercial buildings. Economic forecasts predict a \$1.5 billion market by 1985 and \$10 billion by 2000. Cost-effective solar systems are necessary for increased use. Related problems arise with utility companies, zoning ordinances, building codes and sunrights. The Solar Heating and Cooling Demonstration Act and the Solar Energy Research Development and Demonstration Act in 1974 started the solar programs. Congress raised the solar budget over 150 percent from 1976 fiscal year; however, it received only fourth place in ERDA's budget for energy sources. The solar market increased 155 percent over the first half of 1975, according to the FEA. The president of the SEIA states that 80 percent of the solar installations were privately funded. ERDA sees a possible \$10 billion market by the year 2000. Presently, solar systems are competitive with conventional ones only on a life-cycle cost basis. Manufacturers foresee reduced costs through lower labor costs and larger volume production. Two future challenges are retrofitting structures and developing cost-effective solar cooling systems. Medical buildings, banks, and schools provide large-scale solar systems; however, most building construction is residential. Passive designs for buildings are considered cost-effective.

ST78 13141 Formal Implication of Solar Rights

Arumi, F.N.; Dodge, R.L.
Univ. of Texas, Austin, TX
Jrnl: Energy Build., V 1:183-191 N2 Oct. 1977

A hand method to determine the vertical limits of construction when solar rights criteria are specified for neighboring structures is demonstrated and compared with a computer-based method. The emphasis is placed on the methodology and it includes an appendix showing the logic and the listing of the computer programs.

ST78 13142 Public Policy Issues, A Southern California Gas Company Project SAGE Report

Barbieri, R.; Hirsberg, A.S.
JPL, California Inst. of Tech., Pasadena, CA
Avail:NTIS, N78-19613

The use of solar energy to stretch our supplies of fossil fuels was investigated. Project SAGE (semi-automated ground environment) addresses itself to one application of this goal, solar assistance in central water heating systems for multi-family projects. Public policy issues that affect the rate of adoption of solar energy systems were investigated and policy actions were offered to accelerate the adoption of SAGE and other solar energy systems.

ST78 13143 Site-Dependent Factors Affecting the Economic Feasibility of Solar-Powered Absorption Cooling

Bartlett, J.C.

Int. Business Machines, Huntsville, AL

Annual ASISES Mtg., 1977

Jrnl: Proc. of Mtg., V 1, Secs. 1-13 ASISES, Cape Canaveral, FL

A procedure has been developed which can be used to determine the economic feasibility of solar-powered absorption cooling systems. This procedure has been used in a study to investigate the influence of the site-dependent parameters on the economic feasibility of solar absorption cooling. The purpose of this study was to make preliminary site selections for solar-powered absorption cooling systems. The results of that study are summarized.

ST78 13144 Impact of the National Energy Plan on Solar Economics

Ben-David, S.; Noll, S.; Roach, F.; Schulze, W.

LASL, Los Alamos, NM

Avail:NTIS, LA-UR-77-2694 1977

The National Energy Plan (NEP) sets as a goal the use of solar energy in two and one-half million homes in 1985. A key provision of the NEP (as well as Congressional alternatives) provides for the subsidization of solar equipment. The extent to which these subsidies (income tax credits) might offset the impact of continued energy price control is examined. Regional prices and availability of conventional energy sources (oil, gas, and electricity) were compiled to obtain a current and consistent set of energy prices by state and energy type. These prices are converted into equivalent terms (\$/10⁶ BTU) which account for combustion and heat generation efficiencies. Projections of conventional fuel price increases (or decreases) are made under both the NEP scenario and a projected scenario where all wellhead price controls are removed on natural gas and crude oil production. The economic feasibility (life-cycle cost basis) of solar energy for residential space heating and domestic hot water is examined on a state-by-state basis. Solar system costs are developed for each state by fraction of BTU heating load provided. The total number of homes, projected energy savings, and sensitivity to heating loads, alternative energy costs and prices are included in the analysis.

ST78 13145 Building Rights, Apartment and Residence Designing in the Light of Solar Energy Utilization

Bierhals, R.; Schaefer, G.; Weigert, D.

Institut fuer Systemtechnik und Innovationsforschung, Karlsruhe, W. Germany

"Heating With The Sun II," March 3,4, 1977 Munich, W. Germany

Avail:AIAA, A78-28594 Jrnl: Proc. of Mtg., Rept., V 2:319-341 In German Munich, W. Germany

The feasibility of using solar energy systems for hot water and space heating in the German Federal Republic is reviewed and the problems associated with wide-scale incorporation of solar energy systems into apartment and single-family residence designs are considered. Appropriate roofing materials for use with solar collectors are described. Particular attention is given to the problem of shadows which may be cast on solar collectors by neighboring buildings.

ST78 13146 Payback of Solar Systems

Boer, K.W.

Univ. of Delaware, SES, Inc., Newark, DE

Avail:AIAA, A78-30266 Jrnl: Solar Energy, V 20:225-232 N3 1978 Res. by SES, Inc.

A variety of solar conversion systems is studied in a dynamic economical model in which the real cost of energy inflates. Payback times and dates of probably market entries are estimated. A distributed system to convert solar energy into heat and electricity in direct proximity to the consumer (Solar One System) is economically attractive even for solar cells with well below 10 percent conversion efficiency when these can be installed in flat-plate collectors for less than 30 dollars/m², in addition to the collector cost.

ST78 13147 Economics of UK Solar Energy Schemes

Chapman, P.F.
Open Univ., Milton Keynes, Engnr.
Jrnl: Energy Policy, V 5:334-340 N4 Dec. 1977

This paper establishes a framework for evaluating the cost-effectiveness of solar energy systems, specifically space and water heating, using standard methods of discounted cash flow. The difficulties in applying DCF analysis to solar energy schemes are: long-run production costs of solar components are largely unknown; use of solar energy affects the economics of other fuel-supply systems; domestic solar energy use is strongly dependent on the level of house insulation; future fuel prices are largely unknown; energy savings cannot be directly translated into cash savings since fuel tariffs include a standing charge component; and the appropriate discount rate to be used is uncertain. At present, energy storage costs appear to preclude cost-effectiveness in total energy systems. It has been shown, though, that partial solar schemes can be cost-effective.

ST78 13148 Survey and Evaluation of Alternative Theories of Economic Growth and Technical Change with Special Emphasis on Institutional R and D

Cooper, R.L.; Vanderford, D.E.
Univ. of California, Lawrence Livermore Lab., ERDA, Livermore, CA
Avail:NTIS, UCR-L-52299 40 p. July 22, 1977

After summarizing previous attempts to measure the contribution of technical change to economic growth in terms of investment, experience, R and D, and energy, the R and D theory of factor productivity growth is tested against the other three theories by determining the standard errors of estimate and applying the S-test to each pair of hypotheses. The R and D theory explains factor productivity growth in the US private non-financial sector over the period 1959-1975 marginally better than other theories tested. Assuming the validity of the relationship between R and D expenditures and factor productivity, the recent decline in R and D spending, if allowed to continue, will cut factor productivity growth roughly in half from its post-war average. To restore factor productivity growth to its historical rate of about 2 percent/year over the next decade would require increasing R and D spending 10 percent/year.

ST78 13149 Economics of Solar Heating and Cooling Systems

Corcoran, W.L.
US Dept. of Energy, Demonstration Program Branch, Washington, D.C.
Avail:AIAA, A78-31550 Jrnl: ASHRAE J., V 20:47-50 April 1978

Solar heating and cooling for a private residence are discussed in terms of amortization time for a house with a 30-year mortgage at 8.5 percent. Different collector systems (tubular, flat, concentrating) and sizes are compared, with reference to their initial and life-cycle costs. National energy savings are calculated for widespread use of solar power, which could reach the quad level by 1990. Also mentioned is the prospect of job creation through the development of solar technology, possibly as many as 74,000 new jobs before the end of the century. Economic incentives to encourage home owners to use solar energy are discussed, including property tax exemption for solar units.

ST78 13150 State Solar Energy Legislation of 1976: A Review of Statutes Relating to Buildings

Eisenhard, R.M.
NBS, ERDA, Dept. HUD, Washington, D.C.
Avail:NTIS, PB-273 899/5ST 258 p. Sept. 1977

This report reviews state legislation on solar energy use in buildings enacted in 1976. Acts involve tax incentives for the installation of solar devices, support for the proposed Solar Energy Research Institute called for in Public Law 93-473, solar standards, state energy offices, studies, building requirements, and solar projects. The Acts are identified and abstracted, and responsible state officials are listed.

ST78 13151 Energy Conservation Via Solar Energy Applications to Multi-Family and Commercial Structures, Volume 3, An Energy, Engineering, and Economic Analysis of Heating and Cooling Systems for Multi-Family Structures

Fleming, W.S.; Bender, T.; Jagusztyn, T.; Parkman, P.; Sweetser, D.
State Univ. of New York, Albany, NY, Atmos. Sci. Res. Center.
Avail:NTIS, N78-21637

An energy analysis was made for a multi-family apartment model involving the heating, cooling, lumination, and miscellaneous equipments energy consumption. The analysis compared various heating, ventilating, and air conditioning systems with and without solar assistance to determine their merits on the basis of energy conservation and economic value. An electric resistance heating and electric air conditioning system were utilized as the basis for system comparison. The buildings orientation, U value, and infiltration were also analyzed for consideration of architectural variables.

ST78 13152 Projection of Distributed-Collector Solar-Thermal Electric Power Plant Economics to Years 1990-2000

Fujita, F.; El Gabalawi, N.; Herrera, G.; Turner, R.H.
JPL, Pasadena, CA
Avail:NTIS, DOE/JPL/1060-1 Dec. 1977

A preliminary comparative evaluation of distributed-collector solar-thermal power plants has been undertaken by projecting power plant economics of selected systems to the 1990 to 2000 time frame. The selected systems include: (1) fixed orientation (non-tracking) collectors with concentrating reflectors and vacuum tube absorbers, (2) one-axis tracking linear concentrators including parabolic trough and variable slat designs, and (3) two-axis tracking parabolic dish systems including concepts with small heat engine-electric generator assemblies at each focal point, as well as approaches having steam generators at the focal point with pipeline collection to a central power conversion unit. Comparisons are presented primarily in terms of energy cost (mills/kwh) and capital cost over a wide range of operating load factors. Sensitivity of energy costs for a range of efficiency and cost of major subsystems/components is presented to delineate critical technological development needs. The baseline central receiver or power tower systems using state-of-the-art 1000°-F steam rankine technology is used as a reference case for making comparisons of the selected distributed collector systems.

ST78 13153 Working Toward a National Energy Policy

Fuqua, D.
IGT, Chicago, IL March 1977

Various facets of the overall picture that contribute to the establishment of a comprehensive national energy policy are discussed. The need for reorganization of various federal agencies in order to facilitate implementation of an energy policy is pointed out. Economic incentives that should make bioconversion more attractive as an energy source are considered.

ST78 13154 The Illinois Program for Comprehensive Solar Energy Legislation

Green, B.D.; Pogany, D.Z.; Dunwoody, J.E.
Illinois Dept. of Business and Economic Dev'tment, Springfield, IL; Illinois Inst. for Environ. Quality, Div. of Energy, Chicago, IL
Avail:NTIS, N78-20648 Prep. with Ill. Inst. Environ. Quality

The development of a solar energy program in Illinois, including the formulation of the comprehensive solar energy act of 1977 is examined. A discussion of the need for comprehensive legislation precedes the overview of dynamics.

ST78 13155 Guide to Jobs and Energy

Grossman, R.; Daneker, G.
Environmentalists for Full Employment, Washington, D.C. 1977

Environmentalists for Full Employment (EFFE) advocate that increased energy efficiency plus solar energy development can provide sufficient energy for a prosperous US economy. They do so with less pollution, less disease, less social disruption, and less interference with community, labor union, and individual rights according to EFFE. Further, EFFE feels that Americans need to know this; they need to know that this approach will provide the nation with safe energy, with prosperity, and with jobs. For these reasons, EFFE has prepared this guide.

ST78 13156 Constraints in Solar Life-Cycle Cost Modeling

Halldane, J.F.; Meckler, G.
 Gershon Meckler Assoc., Washington, D.C.
 Annual Mtg. of ASISES, 1977
 Jrn1: Proc. of Mtg., V 1, Secs. 26-38 ISES, Cape Canaveral, FL

The commercialization of solar energy systems is primarily dependent on their cost. Life-cycle costing is a methodology to compensate a high initial solar capital for a low operation cost through less utility energy over time. Present life-cycle cost models tend to be constrained by an emphasis on investment; a traditional "savings approach" in cash flow analysis; large variations in power demand, insolation, and data; a concept of payback period; and an energy benefit alone. Respectively, these problems have failed to provide all the interested parties with meaningful costs; limited the analyses of different time-dependent cash flows; presented a greater professional risk in design; downgraded the difficulty in finding capital; and limited the benefits attributable to a system. These constraints are discussed here. A benefit-resource factor model is presented for assessing a priority of action in designing for a minimal utility energy and a life-cycle cost having both modified demand and functional performance of a space.

ST78 13157 Factors Affecting Market Initiation of Solar Total Energy

Harrigan, R.W.
 Sandia Labs., Albuquerque, NM
 Avail:NTIS, SAND-78-0148C 1978

An economic methodology is introduced for quickly visualizing the effect of various economic, technical, and programmatic actions on the early commercialization of solar total energy (STE). Process heat users are identified as primary candidates for earliest market initiation. In addition, while technical factors such as improved power-conversion efficiency and mirror reflectivity do affect time-of-market initiation, programmatic, and economic factors such as government-induced mass production of solar collectors and investment tax credits have even greater influence on the market initiation of STE.

ST78 13158 Environmental and Safety Implications of Solar Technologies

Holmes, J.G.; Baluss, J.E.; Muhlmaster, P.E.; Miller, S.G.; Super, T.L.; Thomasian, J.B.
 EEA, Inc., Arlington, VA
 Annual Mtg. of ASISES, 1977
 Jrn1: Proc. of Mtg., V 1, Secs. 26-38 ISES, Cape Canaveral, FL

A summary of an eight-volume series of environmental reviews (ERDA 77-47/1-8) prepared for the Environmental and Resource Assessment's branch of ERDA's Division of Solar Energy by Energy and Environmental Analysis, Inc., of Arlington, Virginia, is presented. The series analyzed the wide range of environmental impacts expected to occur through the implementation of the eight solar technologies currently being funded by ERDA: heating/cooling, solar thermal electric, total energy systems, industrial/agricultural applications, photovoltaics, wind, ocean thermal energy conversion, and fuels from biomass.

ST78 13159 Legal Problems of Solar Energy Utilization

Hueber, A.
 "Heating With The Sun II," March 3,4,1977 Munich, W. Germany
 Avail:AIAA, A78-28595 Jrn1: Rept. of Mtg., V 2:343-355 Deutsche Gesellschaft Fuer
 Sonnenenergie, Munich, W. Germany In German

The extent to which people can have a right to sunlight for solar energy use is discussed with attention to the rights of neighbors whose exposure to the sun is reduced by the installation of solar energy devices. The angle of sunlight incidence is considered and a formula for calculating the allowable distance between existing buildings in terms of the height of the added solar device is introduced. The use of regulations to ensure that new buildings possess solar collectors is examined and the goals of a building code are indicated.

ST78 13160 Regulatory Constraints on Solar Energy and Thermal Storage Installations

Koger, R.K.
 Jrn1: Public Util. Fortn., V 101:9-12, N2, Jan. 19, 1978

The market penetration of new technologies such as centralized solar or thermal storage systems will be influenced by the pricing policies of public service commissions.

The growth of energy demand in North Carolina and recent supply difficulties there are used as an economic background for discussing the issue of whether cost of service should be applied to backup solar installations. Evidence indicates that the fixed charges on power facilities are not reduced when solar equipment is introduced because peak demand remains about the same. On the other hand, time-of-day pricing policies could encourage customers with solar equipment to lower their peak demand by installing more thermal-storage capacity. If the electricity supply savings are computed on the basis of storage costs, a solar installation can be shown to be cost-effective. But if off-peak power prices are low, as is true in North Carolina, capital-intensive solar installations are not presently economic. A more promising case is made for retrofitting or equipping new buildings with thermal-storage systems. More electric usage data is needed to determine the extent and desirability of subsidizing solar-heating customers at either the local utility or federal level.

ST78 13161 Solar Shade Control: New Law for a New Technology

Kramer, S.F.; Felt, J.G.

Jrnl: Energy Commun., V 3:213-230 N3 1977

Any proposed legislation should include certain goals for the solar user, the solar energy devices, solar technology, and private citizens. Sun rights, at this time in the United States, are under no common law. The Japanese are developing a set of solar rights laws. However, they do not appear practical or effective at this time for the United States. The authors feel that the best approach to protection of solar rights is the shade control law affecting only trees and shrubs. The shade control law confronts the problem of shadows but does not initiate solar zones as other previous proposals have.

ST78 13162 New Initiatives in Energy Policy

Linden, H.R.

IGT, Chicago, IL 1977

Dilemmas encountered in the establishment of a viable energy policy for the United States are considered. Reasons for the shift in thinking from a goal of energy self-sufficiency by the Nixon and Ford administrations to a more realistic approach are discussed. The need to determine parameters of the role of low-technology (including solar and biomass) versus high-technology options in the future energy picture is emphasized.

ST78 13163 Solar Access and Land Use: State of the Law, 1977

Miller, A.S.; Hayes, G.B.; Thompson, G.P.

Environmental Law Inst., Washington, D.C.

Avail:NTIS, TID-27773 1977

It is generally accepted that property owners in the United States have no right to receive solar energy that would reach their land only after slanting across property owned by others. There is a right, of course, to sunlight falling perpendicularly on your land, with the trifling exception of shadows cast by aircraft. This chapter on land use is a concise summary of the state of the law in the field but does not present recommended solutions or planning and legislative tools. It is a chapter from a larger study, Legal Barriers to Solar Heating and Cooling of Buildings (available NTIS). It is tentatively concluded that a combination of approaches will probably work best. Fortunately, the authors say, from a legal standpoint the owners of structures in the existing built communities are interested in solar heating and cooling. Direct federal role is presently nonexistent and it should be up to states and localities to choose and enact model laws that meet the special needs of their geographic regions. Some actions and procedures are listed. A compilation of 169 notes and references is provided.

ST78 13164 Materials Spark Innovations in Solar Energy Systems

Mock, J.A.

Jrnl: Mater. Engng., V 84:12-15, N7 1976

Solar energy is being developed with solar systems ranging in price from \$6000 to \$20,000 installed. Prices are not likely to decrease. The lower cost systems (around \$2000) are for domestic hot water systems. With state legislation passing financial incentives, solar becomes more appealing. Materials such as copper and aluminum play a large part in the solar heating market. To assure quality merchandise for the market, standards must be met. The American Society for Testing and Materials Subcommittee is identifying a matrix for solar standards. The key component of the solar system is the

collector. The two types of collectors are those cooled by a liquid or by air. For space heating, the air-cooled collector is preferred to the liquid system for its even distribution of the building's heat. Other than the flat-plate collector are the honeycomb and V-groove design. The compound parabolic concentrator developed by Argonne National Laboratory could be used for heating and cooling businesses. Storage is presently either rocks or water. Salt solutions are now experimented with for other types of storage. At NASA's Lewis Research Center, different types of selective coatings are tested for their efficiency. Fluorocarbon film in place of glass is used as an inner glazing for reduction of heat dissipation through the outer glazing. One popular material for solar collectors is roll-bond copper from Olin brass. An Energy Research and Development Administration is funding a program at Battelle for development of more efficient solar cells.

ST78 13165 Impact of Solar Central Electric Technology on the Regulated Utility

Murry, D.A.
Univ. of Oklahoma, Norman, OK
3rd Annual UMR-MEC Conf., 1977
Jrnl: Proc. of Conf. Western Periodicals Co., N. Hollywood, CA

The generation of electricity by solar energy in the US is moving from the design stage to the pilot-plant stage. Some persons have argued that at least some of the base-line technologies are competitors now or are approaching parity with other energy sources, at least when the social costs and benefits are considered. This paper evaluates briefly the institutional framework of the regulated electric utility, the performance impact of a solar electric plant upon an operational utility. It is concluded that under the present regulatory/institutional framework, the solar electric technology will be developed at a date that is slower than the resource-allocation optimal.

ST78 13166 Methodology For Assessment of Need For Solar Trained Skilled Workers

Orsak, C.G.; Barnstone, R.; Morehouse, J.H.; Gibson, H.J.
Navarro College, Corsicana, TX
Annual Mtg., ASISES, 1977
Jrnl: Proc. of Mtg. V 1 Secs. 26-38 ISES, Cape Canaveral, FL

A methodology is presented for assessing the qualitative and quantitative need for trained manpower in the solar energy industry. The assessment procedure described is presently being used in the Navarro College (Corsicana, Texas) study to determine the need for technician training in solar equipment maintenance and installation. The methodology consists of a coordinated initial effort by three separate working groups: an equipment group, a market penetration group, and a skills analysis group. The final solar manpower needs assessment is to be formulated from the combination of the results from the three initial working groups. Additional information on the specific objectives of each of the working groups and their operational procedure is presented.

ST78 13167 New Laws to Encourage Solar Energy Use for Individual Buildings

Robbins, R.L.
Lake Michigan Federation, Chicago, IL
New England Solar Energy Assoc, Townshend, VT 1976

Innovations in building design and construction and in the use of new heating and cooling methods have generally been slow to be applied in the US. Much of this is due to the fragmented and conservative structure of the construction industry. But local and state laws, as well as institutional constraints, have also severely limited change. Seven major legal issues where changes would improve use of solar energy systems are: improving access to solar insolation; optimizing the location of solar energy collectors; improving the private economics of solar energy systems; improving the operation and design of systems through feasible energy backup and utility provision of solar energy systems; removing construction and maintenance problems; and improving financing for and increasing the number of solar energy systems.

ST78 13168 The Economics of Solar Energy

Sayigh, A.A.M.
Riyadh University, Riyadh, Saudi Arabia
Avail: AIAA, A78-27870 Jrnl: Solar Energy Engng., p. 465-476 1977 Academic Press, Inc., New York, NY

In an analysis concerning the cost of a utilization of solar energy, the prime consideration should be given to the capital investment. Solar energy is best used in small power station generation involving usually 10 to 100 kw sizes with an upper limit of 1000 kw. This is due to the almost constant cost of electricity generation by solar energy, irrespective of the size of the station. The cost of solar appliances is discussed, taking into account solar pumps, solar stoves, solar heating and cooling, solar power plants, and solar stills. It is pointed out that the use of solar energy and its economics can only be judged relatively. Collector costs depends on method of construction, the type of material used, and the exact requirements for a particular collector. For generating electricity by the photovoltaic process, the cost is still 10 to 20 times that of conventional methods.

ST78 13169 Economy of a Retrofit Solar System

Schreyer, J.M.
Oak Ridge Y-12 Plant, Oak Ridge, TN
Avail:NTIS, Y-2098 Sept. 1977

A privately financed solar augmented hot water system has been demonstrated to pay off in less than 10 years if a loan is obtained at 10.5 percent interest. Calculations were made on the assumption that electricity costs five cents per kwh and water consumption averages 30 gallons per day (using current technology on an existing dwelling in Tennessee).

ST78 13170 Energy Conservation and a Healthy Economy

Widmer, T.F.; Gyftopoulos, E.P.
Thermo Electron Corp., Waltham, MA
Jrnl: Tech. Rev., V 79:30-40 N7 June 1977

Technology will permit the re-optimization of each energy-consuming task to achieve the same result at equal or lower cost, and use far less energy. In this paper we will show the firm technical and economic bases that underlie this seemingly bold assertion. We will show that there is an enormous opportunity for reduced energy consumption per unit of product in every sector of the economy, and if we do not take advantage of this opportunity, our economic well-being and security will be endangered. The figure of about 8 percent is believed to be fairly representative of the overall energy effectiveness throughout the economy. The 10 percent efficiency given for automobiles actually overstates their performance considerably, since this calculation takes into account only the efficiency of converting fuel energy to tractive effort at the driving wheels. We're not suggesting that energy efficiency will ever approach 100 percent for real devices or processes, even in the remote future. We wish to emphasize, however, that the present low values of efficiencies indicate the enormous opportunity for energy savings and that no fundamental scientific barriers exist to prevent substantial improvements in energy end-use effectiveness.

ST78 13171 Energy Initiatives: In Florida and Elsewhere

Yarosh, M.M.
Florida Solar Energy Center, Cape Canaveral, FL
14th Space Congr. on STBL 1977
Jrnl: Proc. of Congr. Canaveral Council of Tech. Soc's, Canaveral, FL

Recommendations and legislation initiated by the Florida Energy Committee, which led to the creation of the Florida Solar Energy Center, are reviewed. The programs and operation of this center are briefly reviewed. Some problems and promises for the future of solar energy are also discussed.

14,000 THERMAL POWER

ST78 14054 Influence of Design Factors on the Economy of Sea Thermal Power Plants

Anderson, J.H.; Anderson, J.H.Jr
 Sea Solar Power, Inc., York, PA
 4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
 Avail:AIAA, A78-33306 Jrn1: Proc. of Conf., p. II-39 to II-56 Univ. of New Orleans

An attempt is made, using simple examples, to show how efficiency losses can drastically affect the cost of an OTEC plant. Consideration is given to the relationship between heat rejected per unit of power and the thermal efficiency of an OTEC plant and to the following potential losses in OTEC plants: temperature losses, external friction losses, machinery losses, buoyancy losses, external friction losses, and pipe load losses. Some design solutions for reducing OTEC losses are discussed.

ST78 14055 The Potential for Geothermal and Solar Thermal Power Systems

Anderson, J.H.
 Sea Solar Power, Inc., York, PA
 14th Annual Eng. Sci. Mtg. Nov. 14-16, 1977 Bethlehem, PA
 Avail:AIAA, A78-40368 Jrn1: Proc. of Mtg. p. 1297-1315 Lehigh Univ., Bethlehem, PA

An approximate evaluation of potential sources of energy in the world is made. It is concluded that geothermal power and ocean thermal power have by far the greatest potential. A comparison of cooling requirements for various thermal power plants is made. The operating principles of vapor turbine geothermal and sea thermal power plants are discussed. Sea thermal power is concluded to be, by far, our largest potential source of future energy and provides many additional products, such as fresh water, food, fuels, fertilizer, and other chemicals.

ST78 14056 Value of Energy Storage for Direct Replacement Solar Thermal Power Plants

Anderson, T.D.; Kaplan, S.I.; Wilson, J.V.
 ORNL, Oak Ridge, TN
 Avail:NTIS, CONF-780216-2 1978

The general objective of the study was to develop information on energy storage requirements for solar thermal power plants as an aid to planning and implementing the research and development work. The specific objectives of the study are: (1) to derive cost targets (or what can be afforded) for energy storage systems over a range of applications of direct-replacement solar thermal power plants; and (2) to determine the amount of energy storage required for a given cost of storage. The utility applications considered are base-load (100 percent demand factor) and intermediate-load (50 percent and 25 percent demand factor). Locations examined are Inyokern, Chicago, and Philadelphia. The locations selected are intended to provide a representative sampling of US conditions with respect to both solar resources and utility system load patterns. Back-up capacity, economic trade-offs, demand factors, and economic analysis are discussed. It is concluded that the value of energy storage is strongly dependent on the cost of the solar steam supply system and on the cost of back-up fuel. For a given set of these cost factors, the optimum amount of energy storage is a function of the cost of storage. For the range of cost conditions and power plant locations considered in this study, the maximum amount of storage capacity required was estimated to be 15 kwh/kw for a base-load plant located at Inyokern. For intermediate-load plants, the optimum amount of storage capacity was estimated to be less than 6 kwh/kw. Other studies indicate that intermediate-load solar power plants have the best economic potential. It is concluded, therefore, that the energy storage R and D program should focus on storage systems of relatively low capacity, i.e., less than 6 kwh/kw.

ST78 14057 Comparative Assessment of Orbital and Terrestrial Central Power Plants

Caputo, R.
 JPL, Pasadena, CA
 12th ISECE Conf. 1977
 Jrn1: Proc. of Conf., V 2 Am. Nuclear Soc., Inc. La Grange Park, IL

Recent studies of the space power system (SPS) are integrated into a total social cost framework developed for terrestrial central electric power systems. Total social costs include the projection of commercial economics to the time frame of interest, as well as the Federal Research, Development, and Demonstration (RD and D) costs, the health impacts, the resources required, the environmental impacts, and other social costs. The

total energy system is evaluated from mining, construction, operation to deactivation. The SPS system is limited to transporting all materials from the earth's surface to geosynchronous orbit. Use of the moon as a source of materials is excluded as is use of other than geosynchronous orbit for the power satellite. Only silicon photovoltaic is considered as the SPS energy conversion technique. Costs and impacts of the LWR are considered as a reference for nuclear systems, and the low BTU coal gasification with combined cycle gas and steam turbines is considered as a reference for a fossil central electric plant. The ground solar systems considered are solar thermal using the central receiver approach with thermal storage, and solar photovoltaic using the silicon cell with battery storage. The 1985 ERDA low-cost photovoltaic goal of \$0.50/w_{peak} is assumed to be achieved at 13 percent module efficiency. All ground plants are either designed for or operated at an annual average load factor of 0.7 baseload operation.

ST78 14058 An Early Ocean Test Platform Conversion for Thermal Energy Conversion

Donovan, L.K.; Odden, C.R.

US Naval Facilities Engng. Command, Alexandria, VA

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33302 Jnl: Proc. of Conf. p. II-3 to II-5 Univ. of New Orleans

The Hughes mining barge will be converted to OTEC-1, the first major test vehicle to perform operational testing of power cycle components; sea trials are scheduled for 1979. The barge is 324 feet long with a 106-foot beam having a displacement of about 6000 light tons. OTEC-1 will be designed to test components which will produce about 1 mwe (gross) heat exchangers, pumps, cold water pipe, and ammonia system. The three phases of barge conversion are discussed.

ST78 14059 Economics of Internal and External Energy Storage in Solar Power Plant Operation

Manvi, R.; Fujita, T.

JPL, Pasadena, CA

12th ISECE Conf. 1977

Jnl: Proc. of Conf. V 2 Am. Nuclear Soc., Inc. La Grange Park, IL

A simple approach is formulated to investigate the effect of energy storage on the bus-bar electrical energy cost of solar thermal power plants. Economic analysis based on this approach does not require detailed definition of a specific storage system. A wide spectrum of storage system candidates ranging from hot water to superconducting magnets can be studied based on total investment and a rough knowledge of energy in and out efficiencies. Preliminary analysis indicates that internal energy storage (thermal) schemes offer better opportunities for energy cost reduction than external energy storage (nonthermal) schemes for solar applications. Based on data and assumptions used in JPL evaluation studies, differential energy costs due to storage are presented for a 100-mwe solar power plant by varying the energy capacity. The simple approach presented provides useful insight regarding the operation of energy storage in solar power plant applications, while also indicating a range of design parameters where storage can be cost effective.

ST78 14060 Sea Thermal Power Cycles

Van Hemelryck, L.

Univ. of Texas, Port Aransas, TX

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33348 Jnl: Proc. of Conf. p. VIII-12 to VIII-17, Univ. of New Orleans

In power plants based on the utilization of the temperature difference between surface and subsurface waters in tropical and subtropical oceans, the unit costs associated with the deep-sea water flow are, in the case of plants located at or near the surface, bound to be more significant than those related to surface water flow. Efficient use of the deep-sea water flow is indicated by the specific gross power generated, per unit of flow. An investigation utilizing this criterion is conducted regarding the determination of the optimum operating point. It is pointed out that the selection of operating points has to maximize the product of the amount of heat processed by the thermodynamic efficiency of the process and not the efficiency itself. It is shown that the operation of a plant in accordance with the developed principles would result in the release of deep-sea water at a temperature significantly closer to the surface-water temperatures.

ST78 14061 Preliminary Assessment of Nontechnical Issues Related to Industrial
Application of Solar Thermal Energy Systems

Watkins, G.A.; Brown, M.L.; Maiden, B.; Moore, J.; Smail, H.; Solomon, S.
Battelle Columbus Labs., Columbus, OH
23rd ATM April 25-27, 1977 Los Angeles, CA
Avail:AIAA, A78-32112 Jnl: Proc. of Mtg. p. 134-146 Inst. of Environ. Sci.,
Mt. Prospect, IL

A survey of attitudes concerning industrial application of solar energy systems is reported. Representatives of 20 selected process heat industries, eight public agencies, and four universities, as well as others who have knowledge or experience with solar energy systems expressed their opinions concerning 10 economic, institutional, and environmental issues, and the responses are characterized. The 10 issues are economic-technical uncertainties of solar collector systems, noncompatibility of heat requirements, cost differentials, present need for incentives, industry investment criteria, institutional need for government incentives, impact of regulatory action, environmental-system land requirements, ecological effects of glare, pollution reduction.

15,000 THERMIONIC, THERMOELECTRIC

ST78 15059 Thermionic Emission From Electrodes With Raised Surfaces in a Thermionic Converter

Abramova, A.P.; Gunko, V.M.; Kucherov, R.I.

Avail:AIAA, A78-31011 Jnl: Sov. Tech. Physics Letters, V 3:271-273, July 26, 1977

It has been found that by raising the electrode surfaces, the efficiency of a thermionic converter may be enhanced. Particularly, the effect of raised cathode and anode surfaces in the case where the scale dimension of the surface protuberance is much greater than the electron mean free path in the plasma and much less than the Debye length is studied. Boundary conditions for (1) the limiting cases of a one-dimensional surface protuberance and (2) a two-dimensional surface protuberance are defined. An expression is derived for the effect of a protuberance on voltage-current characteristics and plasma properties in the arc mode of a thermionic converter. The expression is based on the transport and continuity equations for electron current, ion current, and electron energy flux.

ST78 15060 Direct Energy Conversion Book

Angrist, S.W.

Allyn and Bacon, Inc. Boston, MA 1976 \$19.95

A comprehensive review of methods for direct energy conversion and energy storage is presented. Included are selected applications and brief reviews of underlying principles of each method. Principal chapter coverage is devoted to thermoelectric, photovoltaic, thermionic, and magnetohydrodynamic generators. Other modes of energy conversion briefly covered are as follows: Nernst effect, ferroelectric, thermomagnetic, thermo-photovoltaic, electrohydrodynamic, electrokinetic, piezoelectric, radiation, direct charging devices, secondary particle collection devices, and fusion power.

ST78 15061 Photoelectric Radiation Density Meter for Concentrator Focal Region Measurement

Bazarov, B.A.; Bazarov, K.; Strebkov, D.S.

Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashkhabad, Turkmen SSR

Avail:AIAA, A78-28892 Jnl: Geliotekhnika N6 p. 32-34 In Russian 1977

A method allowing measurement of radiation flux at any point of a region with high flux density is described. The sensitive element is a high-voltage matrix photocell. Several of these devices are displaced through the focal region of a concentrator at a velocity not exceeding the velocity corresponding to the maximal critical frequency of the P-N junctions of the photocells. If the energy flux exceeds $100,000 \text{ v/m}^2$, the matrix photocells are cooled in a quartz filled tube filled with circulating water.

ST78 15062 Triangular Electrode High Power Density Thermopiles

Brandstetter, A.; Yekutieli, G.

Weizmann Inst. of Sci, Rehovoth, Israel

ITEC Conf. 1976

Jnl: Proc. of Conf. IEEE, Inc. New York, NY

The feasibility of high power density thermoelectric generators has been studied in the past by several parties, both from a physical and a technological point of view, but no devices of practical interest seem to have been thus far proposed. Some recent efforts to test a certain concept involving thin thermoelements sandwiched between metal electrodes of essentially triangular cross-section, and in particular its applicability to direct conversion of concentrated solar energy, are described.

ST78 15063 Thermic Diode Solar Panels

Buckley, S.

MIT, Cambridge, MA

Jnl: Sunworld V 5:7-12 Aug. 1977

The author describes the thermic diode solar panels now at the prototype stage that are a new way to heat and cool a building using solar energy. These panels are based on a new control discipline developed at the Massachusetts Institute of Technology, called thermics, which uses temperature to directly control heat flow. The thermic diode device

allows heat flow in one direction but not in the reverse direction, as an electric diode allows electric current to flow in one direction but not the other. The solar panels let heat flow into a building when the sun shines but prevent heat loss at night or on cloudy days.

ST78 15064 Performance and Cost Evaluation for A Thermionic Topping Power Plant.

Carnasciali, G.; Fitzpatrick, G.O.; Britt, E.J.
 Foster Wheeler Dev'tment Corp, Livingston, NJ
 ASME Winter Annual MTG. Nov. 27-Dec. 2, 1977 Atlanta, GA
 Avail:AIAA, A78-33145 Jnl: Proc. of Mtg. 8. p. Members, \$1.50; Nonmembers, \$3.00

Thermionic topping of a coal-fired steam power plant, which involves rejecting part of the heat output into the steam cycle, has been found to increase overall system efficiency to 46.8 percent, as compared to an efficiency of 37 percent for a standard plant. The thermionic heat exchanger power modules used in the topping design are described and costs of the system are analyzed. A capital cost of \$902/kw and an electricity cost of 47.4 mills/kwh are projected for a current thermionic topping power plant design.

ST78 15065 Ionization in a Low-Temperature Plasma of Rare Gases and Alkali Metals in the Presence of a Beam of Fast Electrons, for Cesium Thermionic Converters

Cherkovets, V.E.; Shestakova, N.G.
 Avail:AIAA, A78-34980 Jnl: Zhurnal Tekhnicheskoi Fiziki V 48:266-276 Feb. 1978
 In Russian:

A formula for ionization rate in a cold plasma of rare gases and alkali metals (Ar, Kr, Xe, Ba, Li, Na, K, and Cs) in the presence of a fast-electron beam is obtained which enables carrying out of calculations without the use of a computer. Effective cross-sections of equilibrium and nonequilibrium ionization of rare-gas and alkali-metal atoms by Maxwellian electrons are calculated. The efficiency of utilizing a fast-electron beam for ionization in cesium thermionic converters is studied.

ST78 15066 Investigation of Reserve Stability of Low-Temperature Thermopiles

Dudkin, L.D.; Markman, M.A.; Sokolova, V.M.
 Jnl: Appl. Solar Energy, USSR (Engl. transl.) V 12:4-8 N5 1976

Results are reported for tests of various types of low-temperature thermopiles in air and in an inert atmosphere, aimed at uncovering factors limiting operating reserve and at finding ways to increase the operating reserve. The thermopiles used N-branches of either Bi₂ (Te, Se)₃ or PbTe in both cases (Bi, Sb)₂Te₃ was used for the P-branches; cobalt was used for the hot-junction connections, thermopiles operating in air fail owing to oxidation of materials both at the boundary with cobalt and along grain boundaries in the region adjacent to the hot junction. During tests in an inert atmosphere, the diffusion layer that forms between the material of the P-branch and the material of the hot connecting bus reduces the strength of the cell and damages it under thermal cycling, resulting in an abrupt increase in internal resistance. The reserve stability of low-temperature thermopiles depends both on the temperature of the hot junction and the operating time, as well as on cell geometry.

ST78 15067 Increased Central Station Power Plant Efficiency With a Thermionic Topping System

Fitzpatrick, G.O.; Britt, E.J.; Carnasciali, G.
 Rasor Assoc., Inc., Sunnyvale, CA
 12th IECE Conf. Aug. 28-Sept. 2, 1977 Washington, D.C.
 Jnl: Proc. of Conf. V 2:1602-1609 Pap. 779266 Publ. by ANS, La Grange Park, IL

Preliminary system studies reported in the past have shown that combined thermionic-steam efficiencies in excess of 50 percent may be achieved. The purpose of this study was to evaluate the THX (thermionic heat exchanger) approach to topping on a basis which permits comparison with recent studies of other advanced power systems. An overall power plant efficiency of 46.8 percent was calculated as compared with an untopped system efficiency of about 36 percent. The estimated capital cost per installed kw was \$902/kw for a plant coming on line in 2000. Possible methods of increasing overall efficiencies to 52 percent and reducing capital costs to \$700/kw were identified. The modular nature of the THX permits their development at relatively low cost.

ST78 15068 Status of Research on Advanced Thermionic Converters

Hatch, G.L.; Rhiner, W.; Rasor, N.S.; Hansen, L.K.
 Rasor Assoc., Inc., Sunnyvale, CA
 12th IECE Conf. Aug. 28-Sept. 2, 1977 Washington, D.C.
 Jrn1: Proc. of Conf. V 2:1563-1567 Pap 779260 Publ. by ANS, La Grange Park, IL

It is shown that it is possible to controllably and continuously elevate the electron temperature in the plasmatron thermionic energy converter from the emitter temperature to the maintenance electron temperature for the diode arc mode. Measurement of the vacuum space charge arising from the emission from a surface in cesium vapor indicates the presence of a substantial negative ion emission current. Apparatus has been constructed for identifying and directly measuring the flux of positive, negative, and neutral species emitted from an electrode surface in a cesium vapor diode, in order to determine the influence of negative ion emission on the effective work function of thermionic converter electrodes. Initial data indicate the presence of H^- , Cs^- , and possibly C^- and Ch^- .

ST78 15069 Thermionic Energy Conversion Topping System; Utilization of Waste Energy From Steam Generators

Huffman, F.N.; Miskolczy, G.
 Thermo Electron Corp., Waltham, MA
 ASME Winter Annual Mtg. Nov. 27-Dec. 2, 1977 Atlanta, GA
 Avail:AIAA, A78-33144 Jrn1: Proc. of Mtg. 8 p. Members, \$1.50; Nonmembers, \$3.00

Thermionic energy converters (TEC) are an attractive means of topping steam cycles in order to utilize the thermodynamic availability between the combustion temperature and the conventional utilization temperature. The thermodynamics and cost of a reference design of a coal-fired, TEC-topped steam system have been analyzed. For the unoptimized system parameters selected, the combined cycle thermodynamic efficiency is 48.4 percent and the power plant efficiency (as well as the overall energy efficiency) is 44.02 percent. Cost factors are competitive. The study identified several avenues to improved performance; namely, higher temperature air preheater, increased heat flux density into the TEC's and elimination of the air as an intermediate heat transfer fluid. With such modification, station efficiencies up to 50 percent appear possible. The performance and cost projections indicate that TEC is a viable candidate for topping steam power plants.

ST78 15070 Investigation of the Efficiency of an Auxiliary Discharge in a Thermionic Power Generator

Kaibyshev, V.Z.; Karetnikov, D.V.; Trutnev, A.L.
 Avail:AIAA, A78-31328 Jrn1: Zhurnal Tekhnicheskoi Fiziki, V 48:30-38 Jan. 1978
 In Russian

The voltage losses in the low-voltage arc of a thermionic electric power generator are known to equal roughly 0.5 V. The present paper deals with experiments aimed at determining whether an auxiliary discharge in an inert gas can be used to reduce the losses. The optimal parameters of the auxiliary emitter and the auxiliary discharge are established. It is shown that the efficiency of the auxiliary discharge depends to a great degree on the electrode work function, and that an adequate work function of the emitter can be obtained by means of barium vapor additions at pressures sufficiently low to prevent any influence of barium on the discharge parameters. A simple physical model is used as a basis to derive analytical relations which correlate well with the experiment.

ST78 15071 Conversion of Solar Energy into Electrical Power by Means of the Thermoelectric Effect

Landecker, K.
 Univ. of New England, Armidale, Australia
 ITEC Conf. 1976
 Jrn1: Proc. of Conf. IEEE, Inc., New York, NY

An outline is given of the design of the thermoelectric elements for the utilization of solar energy. It is found that thermoelements with radial flow of currents in coaxial disks are the most suitable for this application. Overall efficiency of approximately 20 percent seems attainable.

ST78 15072 Thermionic Converter Performance With Oxide Collectors

Lieb, D.; Goodale, D.; Briere, T.; Balestra, C.
Thermo Electron Corp. Waltham, MA
12th IECE Conf. Aug. 28-Sept. 2, 1977 Washington, D.C.
Jrnl: Proc. of Conf. V 2:1555-1562 Pap 779259 Publ. by ANS, La Grange Park, IL

Thermionic converters using a variety of metal oxide collector surfaces have been fabricated and tested. Both work function and power output data are presented and evaluated. Oxides of barium, strontium, zinc, tungsten, and titanium have been incorporated into a variable spacing converter. Tungsten oxide was found to give the highest converter performance and to furnish oxygen for the emitter at the same time. Oxygenated emitters operate at reduced cesium pressure with an increase in electrode spacing. Results for all collectors are presented and discussed.

ST78 15073 Investigation of the Electrical Characteristics of Low-Temperature Thermionic Power Generators

Menabde, N.E.; Tskhakaia, V.K.; Tsakadze, L.M.; Iurev, V.A.; Lebedev, V.N.
Akademia Nauk Gruzinskoi SSR, Fiziko-Tekhnicheskii Institut, Sukhumi, Georgian SSR
Avail:AIAA, A78-31338 Jrnl: Zhurnal Tekhnicheskoi Fiziki, V 48:183,184 Jan. 1978
In Russian

The effectiveness of improving the output characteristics of thermionic electrical power generators by injecting oxygen into the electrode gap was studied at emitter temperatures between 1200 and 1400 C. The electrodes were of plane geometry. Tungsten (110) single crystals were used as the emitter material, and polycrystalline molybdenum or nickel (110) single crystals for the collectors. It is shown that thermionic generators with oxidized electrodes exhibit a better efficiency at emitter temperatures up to 1400 C than at higher temperatures (1450 to 1700 C). The electrical parameters established in the tests are plotted and compared.

ST78 15074 Experiments With Enhanced Mode Thermionic Converters

Oettinger, P.E.; Hussman, F.N.
Thermo Electron Res. and Dev'tment Center, Waltham, MA
Avail:AIAA, A78-29636 Jrnl: IEEE Transactions on Plasma Sci. V PS-6:83-88 March 1978

Reduction of the ionization and scattering losses associated with ignited mode cesium diodes is essential for high thermal-to-electrical conversion efficiency. Use of an auxiliary electrode in conjunction with a noble gas in the interelectrode space should permit more efficient ion generation for space charge neutralization. The characteristics of a thermionic triode utilizing a ring electrode and a dispenser cathode emitter have been studied as a function of xenon pressure, cesium reservoir temperature, spacing, electrode temperature and pulse parameters (i.e., potential, duration, and repetition rate) applied to the auxiliary electrode. Pulsed operation significantly enhanced output power with uniform discharges appearing to be sustained at emitter-collector spacings as low as 0.5 mm.

ST78 15075 Thermionic Energy Conversion, Volume 1, A Bibliography With Abstracts, Final Report, 1970-May 1977

Reed, W.E.
NTIS, Springfield, VA
Avail:NTIS, N78-30705 \$28.00

Research on thermionic power generation, power plant design, converter design, and basic research on thermionic materials are cited in the bibliography. Spacecraft applications are included. This updated bibliography contains 296 abstracts, none of which are new entries to the previous edition.

ST78 15076 Thermionic Energy Conversion, Volume 2, A Bibliography With Abstracts, Final Report, June 1977-May 1978

Reed, W.E.
NTIS, Springfield, VA
Avail:NTIS, N78-30706 \$28.00

A bibliography containing 62 abstracts concerning research on thermionic power generation, power plant design, converter design, and basic research on thermionic materials is presented.

ST78 15077 Solar Thermionic Power Systems for Terrestrial Applications

Shimada, K.; Swerdling, M.

JPL, Pasadena, CA

12th IECE Conf. 1977

Jrnl: Proc. of Conf. V 2 Am Nuclear Soc., Inc., La Grange Park, IL

The results of a feasibility study which showed that a low-temperature high-efficiency thermionic power system can efficiently convert solar energy to electrical energy without heat transport as required by most solar thermal systems are described. A three-dimensional (two-axis tracking) 93 m² parabolic solar concentrator, consisting of mirrors on a foam glass substrate and designed to a concentration ratio (mirror area/aperture area) of 2000 is considered for producing a design temperature of 1100 C (1400 K) at an efficiency of 74 percent. A tracking subsystem must track the sun at an accuracy of a nominal ± 1.0 degree for maximum use of the sun's energy. Each complete solar thermionic power system unit rated at about 20 kwe peak can generate approximately 48×10^3 kwh/yr. In addition, a thermal energy conversion system can be cascaded within the thermionic power system so that the high quality waste heat can be further utilized to increase the net electrical output. An overall system efficiency greater than 40 percent could be achieved with such a system. Potential applications of a solar thermionic power generation system are remote sites (commercial, military, residence), apartment house complexes, heating and cooling, hydrogen production and large power stations. Solar thermionic power plants with power capabilities of 1 through 1000 mwe are considered for making meaningful cost estimates. For example, the specific cost of a 1000-mwe power plant consisting of 50,000 units without power processing is about \$690 kwe. The addition of power processing for injection into the utility bus increases the specific cost to about \$1050 kwe.

ST78 15078 The Problem of Optimizing The Output Characteristics of an Ideal Thermionic Converter

Titkov, A.S.

Avail:AIAA, A78-38934

Jrnl: Zhurnal Tekhnicheskoi Fiziki
In Russian

V 48:767-769

April 1978

The problem of obtaining maximum output power is solved for an ideal thermionic converter with prescribed temperatures of emitter and collector and prescribed output current. An exact analytical expression is obtained for the limiting envelope of volt-ampere curves for an ideal converter; this expression can be used as a standard to evaluate the efficiency of real thermionic converters. As an example, calculations are conducted for the case of an emitter temperature of 2100 K and a collector temperature of 1050 K. A maximum output power of 5×10^8 w/cm² is obtained.

ST78 15079 Electrodes for Low-Temperature Thermionic Energy Converters: Recent Results and Compatibility Considerations

Von Bradke, M.

DFVLF, Stuttgart, Germany

12th IECE Conf. Aug. 28-Sept. 2, 1977 Washington, D.C.

Jrnl: Proc. of Conf. V 2:1582-1589 Pap 779263 Publ. by ANS, La Grange Park, IL

Two different work functions measuring methods for low-temperature thermionic converters are described. In the high-temperature range thermionic emission microscopes are suitable, especially for the study of cermet emitters with their heterogeneous surface since they allow local work function measurements on particular patches. For collector development of a special electron beam retarding potential method working in the low-temperature range offers the opportunity of measurements at electrodes with mixed absorption layers, which up to now, have been most promising for realizing very low work function values. Applications of these methods are described.

16,000 OCEAN THERMAL ENERGY CONVERSION

ST78 16138 Annual Conference on Ocean Thermal Energy Conversion, 4th, University of New Orleans, New Orleans, LA March 22-24, 1977 Proceedings

Conf. Supp'd by ERDA, Univ. of New Orleans, 630 p. 1977 \$20.
Avail:AIAA, A78-33301

The OTEC conference is divided into the following sections: total systems, mission analysis, environmental and siting considerations, ocean engineering, heat exchangers, biofouling and corrosion, and alternative power cycles. Particular papers are presented on economic incentives for the commercialization of OTEC, the potential mariculture yield of OTEC plants, an estimate of the impact of OTEC operation on the vertical distribution of heat in the Gulf of Mexico, resource assessment of a high potential OTEC site near Puerto Rico, and some factors affecting the selection of OTEC plant platform-cold water pipe designs. Also considered are enhanced single-phase heat transfer for OTEC systems, primary biofouling films and OTEC heat exchangers, and the effects of sea water leakage on the performance of the ammonia cycle for OTEC plants.

ST78 16139 Offshore and Underground Power Plants, Book

Park Ridge, NJ, Noyes Data Corp., Energy Tech. Review no. 19, Ocean Tech. Review no. 6, Avail:AIAA, A78-35574 319 p.

The underground pumped storage concept is examined, taking into account site selection, site investigation, access to underground facilities, material and equipment handling, shaft construction, rates of construction, upper reservoir facilities, the function of the lower reservoir, power plant facilities, and aspects of schedule, costs, and operation. Underground nuclear power plants are discussed along with floating shallow water nuclear plants, floating deep water nuclear plants, sea bed and island nuclear plants, offshore coal-fired power plants, wave power, tidal power, the possibility to obtain electric power from oceanic currents, a utilization of salinity gradients, and sea thermal power plants based on thermal gradients. Products and services considered in connection with an evaluation of offshore windpower systems are related to the heating and cooling of buildings, the refueling of aircraft and other transportation systems, and nitrogenous fertilizer.

ST78 16140 Resource Assessment of a High Potential OTEC Site Near Puerto Rico: Ocean Thermal Energy Conversion

Atwood, D.K.; Duncan, C.P.; Stalcup, M.C.; Barcelona, M.J.
NOAA, Miami, FL

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33323 Jnl: Proc. of Conf. p. IV-74 to IV-78 Univ. of New Orleans

Environmental assessment of potential OTEC sites near Puerto Rico indicates that a high potential site exists off the southeast coast. The temperature gradient to 1000 meters can be as high as 24 C (43° F) and is never less than 20 C (36° F). The insular slope at the site is steep and water depths of 1000 meters exist within 1.5 miles off shore. Geostrophic conditions guarantee a warm thick mixed layer with surface currents of the order of 1/3 of a knot. The supply of cold water can be considered limitless. The site is protected from north and northeast swell, and a mild sea state exists all year round (except during hurricanes). The salinity, temperature, and nutrient distributions at the site are typical of open tropical seas, making the site ideal for a prototype OTEC plant.

ST78 16141 Ocean Thermal Energy: Status and Prospects

Avery, W.H.

Johns Hopkins Univ., Laurel, MD

MTS and AIMPE Symp. Sept. 15, 1977 Rosslyn, VA

Avail:AIAA, A78-35876 Jnl: Marine Tech. Soc. J. V 12:9-16 April-May, 1978

The term OTEC describes a method for generating power by using the warm water at the surface of the tropical oceans in combination with the cold water available at a depth of half a mile to operate a heat engine. A description is given of an optimized OTEC-ammonia-fuel cell system which could deliver a base-load electric power to the user at a cost averaging about 30 mills/kwh (in 1975 dollars). The system can deliver not only base-load power, but if adequate fuel cell capacity is provided, can also deliver intermediate-load power at approximately 33 mills/kwh and peak power at 50 to 60 mills/kwh on demand. It is found that OTEC-ammonia-electric power promises to compete favorably in cost with other options and can provide a future basis beginning by 1990 for an energy economy primarily based on OTEC ammonia that will be stable in price and available on an equal basis to the whole world.

ST78 16142 Steam Lift Cycle at Very Low Mist Densities for Ocean Thermal Gradient Hydraulic Power Plant

Beck, E.J.

Design Services, Ventura, CA

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33349 Jrnl: Proc. of Conf. P. VIII-18 to VIII-26 Univ. of New Orleans

An evaluation study is conducted of the ocean thermal gradient hydraulic power plant and the steam lift pump (SLP). It is pointed out that the feasibility of building SLP's at high temperature has been demonstrated and that an approximate design method has been developed for the case in which steam-water ratios are such that stable bubbles can be maintained over most of the active length of the SLP. The feasibility of low-temperature SLP's, while briefly explored, has not been demonstrated. The immediate tasks in the development of large-scale SLP's are the demonstration and quantification of design techniques to form drops of suitable size by breaking rapidly moving bubbles and to elevate them to a useful height in a high velocity low-pressure temperature stream. Following demonstration of the drop-support phases, a complete numerical method of SLP design, based on the best empirical design factors available, will be needed.

ST78 16143 Operational Sea State and Design Wave Criteria; State-of-the-Art of Available Data for USA Coasts and the Equatorial Latitudes; Ocean Thermal Energy Conversion Platform Design

Bretschneider, C.L.

Univ. of Hawaii, Honolulu, Hawaii

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33322 Jrnl: Proc. of Conf. p. IV-61 to IV-73 Univ. of New Orleans
ERDA-supp'd Research -

In designing ocean thermal energy conversion (OTEC) platforms, it is critical to accurately evaluate the conditions of the ocean environment. Project OPES-DEWAC (operational sea state and design wave criteria) is an effort to parameterize conditions in the waters off the US coastline, including Hawaii, and in the equatorial regions between 20 degrees N and 20 S. Tables are presented listing wind, wave, and current measurements for a given area. Attention is given to the history of hurricanes and typhoons in tropical regions.

ST78 16144 Corrosion and Biofouling on an Ocean Thermal Energy Conversion Plant - What are the Questions

Castelli, V.J.

US Naval Material Command, David W. Taylor Naval Ship Research and Dev'tment Center, Annapolis, MD

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33343 Jrnl: Proc. of Conf. p. VII-34 to VII-36 Univ. of New Orleans

Efforts to control biofouling on ocean thermal energy conversion (OTEC) platforms have focused on two approaches: chemicals and structural materials. Included in the chemical approach are organic toxins, copper salts, and organometallics. The structural approach has lead to experiments with carbon and low alloy steels, organotin rubber sheeting, carbon composites, bronze, and to some extent, aluminum. At present, fouling control is effective for a maximum of three years in temperate waters; less in the tropics.

ST78 16145 Ultra Clean Heat Exchangers: A Critical OTEC Requirement

Conn, A.F.; Rice, M.S.; Hagel, D.

Hydronautics, Inc., Laurel, MD

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33341 Jrnl: Proc. of Conf. p. VII-11 to VII-14 Univ. of New Orleans
Res. supp'd by Battelle Memorial Inst.

Cleanliness of the heat exchanger tube so as to maintain large heat transfer coefficients has been identified as one of the critical requirements for successful operation of an OTEC power plant due to the already very low thermal efficiency which is projected for this concept. It has been estimated that it may be necessary to keep the microfouling layer (slime and other deposits) on the sea water side of the tubes down to a thickness of only 0.001 in. (25 microns). The objective of this study is to provide a catalog of methods now used to maintain the cleanliness of conventional heat exchangers, either by preventing or removing fouling, and to assess critically the applicability of each method for OTEC. Preliminary results and conclusions from this on-going study are presented.

ST78 16146 Marine Thermic Energy and the Combination of Solar, Radiative, and Aeolian Energies

Dauvillier, A.

Avail:AIAA, A78-36623 Jrnl: Revue de L'Energie, V 29:142-145 March 1978 In French

A thermodynamic process for the generation of energy is presented which uses meteorological elements through the creation of a heat source due to daytime rays and a cold source due to nighttime rays, plus a minor addition of Aeolian energy obtained by a heat pump. Marine thermic energy, the radiation process, Aeolian energy, and the problem of sites and construction are all successively studied in this article.

ST78 16147 Solar Sea Power Plants: Prospects and Problems

Dixit, D.K.; Ramaprasad, M.S.

Nat'l Solar Energy Convention Nov. 29-Dec. 1, 1976 Calcutta, India
 Avail:AIAA, A78-42163 Jrnl: Proc. of Convention Jadavpur Univ., Calcutta, India
 p. 230-232

The feasibility of energy production using solar sea power plants (SSPP) located off the coasts of tropical countries is discussed in terms of the basic physical principles involved in their operation. It is noted that the thermal efficiency of SSPP is low compared to that of conventional plants due to the smaller available temperature differential. Thus, boiler tube area must be increased. The expense of the increase is offset, however, by a reduction in tube thickness made possible by the lower vapor pressures encountered, and by the lower temperature in the tubes, which obviate the necessity of expensive alloys. The possibility of generating vapor by fluids other than water, e.g., ammonia or propanol, is discussed. Hazards to SSPP are considered, especially microbial fouling (which can be dealt with using 0.25 ppm chlorine) and storms (whose effects are lessened by submergence).

ST78 16148 Technical and Economic Feasibility of Ocean Thermal Energy Conversion

Dugger, G.L.; Francis, E.J.; Avery, W.H.

Johns Hopkins Univ., Laurel, MD
 Jrnl: Solar Energy, V 20:259-274 N3 1978

A review of the literature is presented on the engineering feasibility of closed-rankine-cycle, ocean thermal energy conversion (OTEC) plants which has been assessed by many independent investigators in recent years. Various OTEC plant-ship concepts, their economics, onboard production plants and some of the environmental considerations are discussed. An implementation plan for tropical plants producing ammonia and aluminum plus plants off the lower United States' utility grids has been suggested.

ST78 16149 Experiments on and Design of Low-Cost Aluminum Heat Exchangers for OTEC Plant Ships

Dugger, G.L.; Olsen, H.L.; Pandolfini, P.P.; Avery, W.H.

Johns Hopkins Univ., Laurel, MD
 4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
 Avail:AIAA, A78-33339 Jrnl: Proc. of Conf. p. VI-111 to VI-123 Univ. of New Orleans

In order for OTEC stations to be adopted into the overall scheme of energy production, they must be economically competitive with land-based power stations. The most expensive elements of OTEC stations are the evaporators and the condensers. Aluminum has traditionally been used in the construction of these elements, largely because of its low cost. A description of the structural characteristics of aluminum heat exchangers presented, i.e., a two-phase heat flow construction (ammonia inside, sea water outside) is integrated with a barge-type reinforced concrete hull. Each 2.5 mw evaporator or condenser module has 259, 76 mm O.D. tubes approximately 730 ft long, folded to 27 horizontal passes each; seven of which are nested in a vertical plane in each of 37 elements. An evaluation of the costs involved in such an assembly is presented, together with a description of the assembly techniques. Inlet quality (mass percent vapor) for a single tube was varied from 0 to 20 percent with a digitally modularized, steam jacketed preheater. Some flow stratification occurred at low values, but heat transfer coefficients were in general agreement with the Chaddock-Brunemann correlation.

ST78 16150 An Early Ocean Test Platform for Testing Cycle Components in Ocean Thermal Energy Conversion

Falconer, R.W.; Cohan, F.A.; Smith, M.J.
 Mechanics Res., Inc., Santa Monica, CA
 4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
 Avail:AIAA, A78-33303 Jnl: Proc. of Conf. p. II-6 to II-10 Univ. of New Orleans

A five-month study has shown that the Hughes Mining Barge (HMB) is ideally suited for use as the OTEC early ocean test platform (EOTP) using a 1-mwe power plant. The general arrangement evolved from systematic tradeoff analyses which considered the EOTP system requirements, operational suitability, technical feasibility, risk, and cost effectiveness. These analyses identified the necessary HMB physical modifications to accommodate the planned OTEC plant, crew accommodations, and support equipment. It was established that the only EOTP system having unique design requirements was the pipe handling system (i.e., all other systems can be composed of off-the-shelf items).

ST78 16151 Corrosion Fatigue of 5086-H34 Aluminum in Sea Water for Ocean Thermal Energy Conversion

Flooder, S.P.; Hartt, W.H.
 Florida Atlantic Univ., Boca Raton, FL
 4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
 Avail:AIAA, A78-3334 Jnl: Proc. of Conf. p. VII-41 to VII-45 Univ. of New Orleans

Results are presented for an experimental investigation of corrosion fatigue crack growth in 0.500-in-thick symmetrical center-cracked plate specimens of 5086-H34 aluminum in air and in sea water. A procedure involving precracked specimens is selected as it permits obtaining substantial information from relatively few tests. Of particular interest is the range of low stress intensities where little data are presently available. Limited experiments with cathodic protection are also performed. Plots of crack growth rate versus stress intensity show ranges of stress intensity where corrosion is most detrimental and where cathodic protection is most advantageous. Significance of the experimental results for ocean thermal energy conversion systems is discussed.

ST78 16152 Market Definition, Commercial Development Plan, and OTEC Financing: A Summary of 1976 APL Work for the US Maritime Administration

Francis, E.J.; Seelinger, J.
 Johns Hopkins Univ., Laurel, MD
 4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
 Avail:AIAA, A78-33313 Jnl: Proc. of Conf. p. III-58 to III-66 Univ. of New Orleans

A concept for ocean thermal energy conversion (OTEC) plant ships for the onboard production of ammonia or other products at tropical sites has been developed. Liquid ammonia could be shipped to the US to supply fertilizer and chemical markets or as a carrier of hydrogen for use in fuel cells to produce electricity. A cost estimate for a 100-mwe, 313-short-ton/day, demonstration-size OTEC ammonia plant ship provided the basis for cost estimates for commercial-size ships producing 1000 tons/day or more of ammonia. Economic and marketing analyses have been conducted to provide forecasts bearing on the commercialization potential for the 1983-2000 period, including ammonia production costs and prices, US and world market penetration, and benefits to the US and the world from a successful program. Less extensive analyses have been conducted for OTEC aluminum production and for the case of direct transmission of OTEC electric power to US and foreign shores.

ST78 16153 Preliminary Analysis of the Effects of Sea Water Leakage on the Performance of the Ammonia Cycle in Ocean Thermal Energy Conversion Plants

Hafezzadah, H.; Johnson, D.W.; Starling, K.E.
 Univ. of Oklahoma, Norman, OK
 4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
 Avail:AIAA, A78-33351 Jnl: Proc. of Conf. p. VIII-31 to VIII-35 Univ. of New Orleans

The effects of water contamination on an OTEC power plant utilizing ammonia as the working fluid were investigated with reference to power cycles with and without recycle around the evaporator. The thermodynamic effects of increasing the water concentration in an optimized ammonia cycle plant were analyzed by means of the Han-Starling generalized correlation with appropriate parameters for ammonia-water mixtures. In the analysis and in a study using an OTEC simulator it was assumed that an actual OTEC-ammonia plant was operating at an offshore location. The results indicate that a small amount of water could be tolerated without serious degradation in cycle performance, and that the amount of water which could be tolerated increased as the recycle ratio around the evaporator increased.

ST78 16154 Hydrodynamic Loads on the Cold Water Pipe for Ocean Thermal Energy Conversion Application

Hove, D.T.; Shih, W.C.L.
 Science Applications, Inc., El Segundo, CA
 4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
 Avail:AIAA, A78-33326 Jrnl: Proc. of Conf. p. V-23 to V-39 Univ. of New Orleans

A long cylindrical cold water pipe is part of every proposed OTEC design. Pressure variations on the pipe have been analyzed in terms of lift, drag, and strouhal shedding frequency for Reynolds numbers in the one to 10 million range. An analytical technique is evaluated, which extends lower Reynolds number data to higher Reynolds values by modeling the influence of roughness on cylinder boundary layer flows.

ST78 16155 Investigations of Mixing and Recirculation in the Vicinity of an Ocean Thermal Energy Conversion Plant

Jirka, G.H.; Fry, D.J.; Johnson, R.P.; Harleman, D.R.F.
 MIT, Cambridge, MA
 4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
 Avail:AIAA, A78-33318 Jrnl: Proc. of Conf. p. IV-35 to IV-41 Univ. of New Orleans

Experimental and analytical studies on the external fluid mechanics in the vicinity of an ocean thermal energy conversion (OTEC) plant are conducted. Schematic OTEC conditions defined by a mixed discharge mode and a discretely stratified ocean are assumed. The interaction of several fluid mechanical regions, a jet entrainment zone, an intermediate buoyant layer, and an intake flow zone is simulated in a shallow laboratory basin representing the upper layer of the stratified ocean. A concurrent analytical model development gives satisfactory agreement with the experiments and allows to define an approximate criterion for the existence of recirculation of discharge water back into the plant intake.

ST78 16156 Thermo-Hydraulic Energy From the Sea

Johnson, D.G.
 Norges Tekniske Hogskole, Trondheim, Norway
 IFAET Conf. Oct. 31-Nov. 2, 1977 Sussex, England
 Avail:AIAA, A78-31274 Jrnl: Inst. of Fuel J., V 51:59-63 March 1978

The paper describes the possibilities and problems of thermal energy production from heat stored in tropic waters, so-called ocean thermal energy conversion (OTEC). OTEC plants, technically realizable today, have not yet been built, owing to prohibitively high investment costs. The author proposes a new thermo-hydraulic system named ocean thermo-hydraulic energy conversion (OTHEC). In this relatively cheap system water will be pumped by means of steam and used for driving a water turbine. The simplest OTHEC plant will have a steam lift tube as a pumping device. Laboratory experiments have verified that the steam lift tube will work stably and give a positive static head of some four metres, when the temperature difference is 20 C and the hot water temperature 55 C. The effect, though, is small and efficiency low. Further research will be necessary, especially with lower hot water temperatures, to improve the steam lift tube design and also to investigate other possible OTHEC variants as well.

ST78 16157 The Earth as a Solar Heat Engine: Windpower Utilization, Ocean Thermal Conversion, Tidal Power, Waterwave Power and Biomass Conversion

Kenton, J.
 EPRI, Palo Alto, CA
 Avail:AIAA, A78-30745 Jrnl: EPRI J. V 3:43-48 March 1978

The utilization of indirect solar energy sources is discussed. New developments concerning the employment of wind power are partly related to research conducted by NASA working in cooperation with DOE. The huge airfoil blades on which modern wind-power machines are based are mounted with variable-pitch gears so that the blade angle of attack can be varied to obtain optimal aerodynamic efficiency over a range of wind speeds. The federal wind energy program covers five areas, including program development and technology, small machines for farm and rural use, 100-kw-scale systems, megawatt-scale systems, and large multi-unit systems. Attention is also given to wind power problems, approaches for utilizing wave power, techniques for ocean-thermal conversion, tidal power problems, and the prospects of biomass conversion.

ST78 16158 Ocean Thermal Energy Conversion Legal, Political, and Institutional Aspects

Knight, H.G.; Nyhart, J.D.; Stein, R.E.
Louisiana State Univ., Baton Rouge, LA
Avail:AIAA, A78-28750 Book: D.C. Heath and Co., Lexington, MA 257 p. 1977

Ocean thermal energy conversion (OTEC) systems, which would make use of the natural temperature differential between surface and deep waters to generate power, are currently under development; a 25-mw prototype plant developed under the auspices of ERDA is scheduled to begin operation by 1985. Critical elements of OTEC technology include heat exchangers, cold and warm water pumps, cold water piping, mooring arrangements, and turbomachinery. However, the emphasis in this book is placed not on technical problems, but rather on the issues of international law that OTEC plants may raise. In particular, spatial and emerging use conflicts, liability, US federal and state regulations, and legal aspects of OTEC plant financing are considered.

ST78 16159 Potential Mariculture Yield of Sea Thermal Power Plants, II, Food Chain Efficiency

Laurence, S.; Roels, O.A.
Univ. of Texas, Port Aransas, TX
4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33309 Jnl: Proc. of Conf. p. III-21 to III-25 Univ. of New Orleans

The results of a series of experiments designed to determine the potential organic productivity of an OTEC mariculture system in tropical or subtropical oceans are presented. It has been shown at the St. Croix Artificial Upwelling Laboratory that plant nutrients (such as nitrate and phosphate) brought to the surface from deep-sea water and exposed to sunlight can be used for phytoplankton production in a continuous system; this phytoplankton is then fed to shellfish whereby animal protein is produced. The conversion efficiency of available nutrients and the protein production per unit area of this mariculture system were superior to conventional agricultural systems. It is concluded that a combined energy and food-producing OTEC system appears much more desirable than an energy-producing plant alone.

ST78 16160 A Comparison of Two Generic OTEC Systems and Missions: Ocean Thermal Energy Conversion

Lavi, G.H.; Zener, C.
Carnegie-Mellon Univ., Pittsburgh, PA
4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33304 Jnl: Proc. of Conf. p. II-11 to II-21 Univ. of New Orleans

Comparisons are made between electrical (20-30 mills/kwh transmitted to shore) vs. chemical (10 mills/kwh produced at sea for the production of ammonia and other chemicals) OTEC utilization, near shore vs. open sea installation, and shell and tube vs. plate-type heat exchangers. It is argued that the electric power mission involving direct delivery to the United States mainland and possessions is economically the best. If the busbar cost of OTEC power can be reduced, the first demonstration plant can more profitably employ an over-designed vessel (semi-submersible type) located near the United States than a simpler vessel (barge type) located in the open seas. It is noted, however, that because of the potentially lower cost of the plate-type variety, the continued development of the plate-type design and other shell-less heat exchangers is justified.

ST78 16161 Ocean Energy Industrial Complexes

Lindal, B.; Hornburg, C.D.; El-Ramly, N.
DSS Engrs., Inc., Ft. Lauderdale, FL
4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33311 Jnl: Proc. of Conf. p. III-34 to III-46 Univ. of New Orleans

A feasibility study was conducted with the purpose of examining the economic, technological and environmental aspects of the recovery of marketable chemicals from sea water and the production of other energy intensive products in conjunction with floating OTEC plants. Analysis of production methods and other data on 62 major products led to the selection of 23 of these for further study. Production was grouped into five separate potential complexes. Further market and transportation studies showed that production in a sea-chemicals complex and an organic chemicals and plastics complex has the highest economic potential.

ST78 16162 Cold Water Transport, Cold Water Pipe, and Deep Water Mooring Line Analysis, A Parametric Approach for Ocean Thermal Energy Conversion

Little, T.E.

Westinghouse Electric Corp., Annapolis, MD

4th AOTEC Conf., March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33327 Jnl: Proc. of Conf. p. V-40 to V-48 Univ. of New Orleans

The successful implementation of the ocean thermal power plant is dependent upon the technical and economic feasibility of transporting large volumes of cold water from sea depths of 500 meters or more through suitable ducting to the power plant condensers. In addition, plant platform station keeping must be provided by a mooring arrangement and/or by use of dynamic positioning. Highlights of the analysis and evaluation of the cold water transport, cold water pipe, and deep water mooring lines are provided with a view toward judging the impact of these subsystems on the overall OTEC plant platform concept and to provide an estimate of material and construction cost. The merits of candidate subsystems over a range of plant size from 100 mwe to 1000 mwe net output power.

ST78 16163 An Outline for Optimizing and Evaluating Proposed OTEC Systems: Ocean Thermal Energy Conversion

Lyon, R.N.

ORNL, Oak Ridge, TN

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33333 Jnl: Proc. of Conf. p. VI-34 to VI-38 Univ. of New Orleans
ERDA-spons. Research

The development of a suitable approach for an optimization of an ocean thermal energy conversion (OTEC) system is considered. It appears to be advisable to develop at an early stage a generalized computer model and optimization program, which could be tested with respect to its correctness and be accordingly modified. The model could then provide a suitable basis for selecting the lines of OTEC system development and for avoiding decisions leading to less than optimum paths. A truly general model should fit all possible OTEC concepts. To date these concepts include vapor-turbine (or "rankine cycle") systems and hydraulic turbine systems. A description is presented of a logical order of computation for a given set of values for the parameters and independent variables. The final part of an optimization program, which may in fact dominate the modeling, is the determination of the optimum set of values for the independent variables.

ST78 16164 A Design and Producibility Study of Heat Exchangers for Ocean Thermal Energy Conversion Systems

Manikowski, A.F.; Pfluger, A.R.

Lockheed Missiles and Space Co., Inc. Sunnyvale, CA

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33340 Jnl: Proc. of Conf. p. VI-135 to VI-137 Univ. of New Orleans
ERDA-supp'd Research

Potential shell-and-tube heat exchanger design concepts that are economical and within the reach of current technology for ocean thermal energy conversion (OTEC) systems are examined. Although the Lockheed concept is used as a basis, the design and manufacturing approaches identified are generally applicable to any large shell-and-tube heat exchanger. The discussion concerns both titanium-tubed and aluminum-tubed designs. The pressure vessels assessed include monocoque cylinders and spheres, and ring-stiffened cylinders produced with aluminum, steel, and concrete. The aluminum baseline design is employed as a basis for developing manufacturing plans and estimating costs of the heat exchangers. A computer optimization program is used to define the power-cycle parameters for a 25-mw(e) power module. Achievement of the economies indicated for aluminum requires an engineering and manufacturing development program to develop an engineering and manufacturing development program to develop tube-to-tubesheet joining techniques for a reliable joint from a mechanical and leakage standpoint.

ST78 16165 Air Conditioning Using Ocean Thermal Gradients

Mannan, K.D.; Singh, D.

Punjab Agricultural Univ., Ludhiana, India

Nat'l Solar Energy Convention Calcutta, India Nov. 29-Dec. 1, 1976

Avail:AIAA, A78-42160 Jnl: Proc. of Convention p. 221,222 Jadavpur Univ.

A large (1000 ton) centralized air conditioning facility is proposed for the city of Madras, India. The city has an average dry bulb temperature of 38.5 C in summer, with a relative humidity of 47 percent. The air conditioning facility, to be located 4.5 km offshore, would use the deep layers (below 1000 m) of sea water to provide indoor

temperatures of 26 C and 65 percent relative humidity. The cost of manufacturing such a facility would be roughly equal to the cost of conventional air conditioning, but its energy requirements are expected to be 70 percent lower. Critical to the practicability of the scheme is the assumption that the water reaches the air conditioning unit at 59° F or less.

ST78 16166 An Estimate of the Impact of OTEC Operation on the Vertical Distribution of Heat in the Gulf of Mexico

Martin, P.J.; Roberts, G.O.
Science Applications, Inc., Fluid Mech. Div., McLean, VA
4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33317 Jnl: Proc. of Conf. p. IV-26 to IV-34

The effect of OTEC operation on the vertical thermal structure of the Gulf of Mexico is estimated on the basis on a one-dimensional Z-T heat conservation equation to predict the horizontal mean temperature. It is indicated that the effect of the operation of 100 200-mw OTEC plants on the mean vertical thermal structure of the gulf would be fairly slight. With complete recirculation of plant intake and discharge flows within the gulf, the predicted drop of the mean sea surface temperature is about 0.05 C and the rate of warming of the deep water between the cold water intake and discharge levels is about 0.03 C/yr. Even with 1000 plants, the drop in the mean sea surface temperature is less than 0.5 C. Recirculation between the cold water intake and discharge flows with such a large number of plants has the potential to decrease significantly the available thermal resource due to warming of the deep water.

ST78 16167 Gulf Stream OTEC Resource Potential

McCluney, W.R.; Sivak, L.D.
Florida Solar Energy Center, Cape Canaveral, FL
Avail:AIAA, A78-32535 Jnl: J. of Energy, V 2:120-122 March-April 1978

Florida current oceanographic parameters are analyzed in a study of the feasibility of ocean thermal energy conversion (OTEC) plants located near the coast of Florida. Both the temperature differential and the mean flow required for an OTEC power installation are provided by the current, which is also conveniently near a large-scale electric power network in the southeastern US. Available heat flux in the current is analyzed, and calculations for the parasitic power needed to pump sea water and ammonia (the heat transfer fluid for the power plant) are performed. The preliminary computations indicate that the large thermal resource potential of the current may offer an excellent site for OTEC plants.

ST78 16168 Analytical and Experimental Studies of OTEC Heat Transfer Problems at Oak Ridge National Laboratory

Michel, J.W.
ORNL, Oak Ridge, TN
4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33331 Jnl: Proc. of Conf. p. VI-15 to VI-26 Univ. of New Orleans
ERDA-spons. Research

During the past year, Oak Ridge National Laboratory has been involved in assisting ERDA in the analysis, planning, and implementation of a program to develop advanced heat exchangers for ocean thermal energy conversion (OTEC) application. An analysis of the NH₃ binary cycle and the current state of commercial heat exchanger technology indicated that the goals of this program should be to improve the sea water heat transfer coefficients by a factor of two, the ammonia heat transfer coefficients by a factor of two to four, and to be able to control fouling factors at a value of 0.0003 or below. These improvements coupled with qualifying aluminum for this sea water ammonia service would go far toward assuring the economic viability of the OTEC concept. A single tube ammonia heat transfer loop has been built and operated to evaluate the heat transfer characteristics of fluted tubes. Preliminary ammonia condensation results are presented.

ST78 16169 Ocean Thermal and Current Velocity Data Requirements for Design of An OTEC Demonstration Plant

Molinar, R.L.; Festa, J.F.
NOAA, Miami, FL
Avail:NTIS, N78-29622

The requirements for oceanographic data needed in the design of an OTEC demonstration plant and a methodology for obtaining ocean thermal and current velocity data are presented. In addition, some requirements for environmental impact data are given.

ST78 16170 Screens for the OTEC Plants, Protection from Biological Materials for Ocean Thermal Energy Conversion Heat Exchangers

Nath, J.H.; Ambler, J.W.; Hansen, R.M.
Oregon State Univ., Corvallis, OR
4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33329 Jnl: Proc. of Conv. p. V-56 to V-69 Univ. of New Orleans

The reported investigation had the objective to determine the kinds and quantities of biological materials which must be excluded from an ocean thermal energy conversion (OTEC) Rankine plant, taking into account also the development of suitable methods for implementing such an exclusion. The existing biological information is obtained from the results of sampling fish with mid-water trawls. It is pointed out that this sampling condition is considerably different from that of an OTEC plant which will be sucking in large quantities of warm and cold water. An important part of the investigation is, therefore, concerned with the development of a suitable sampling method which reproduces the conditions prevailing in an OTEC plant. The investigation takes into account the eastern and southern coasts of the US, the tropical seas to $\pm 20^\circ$ latitude, and the region around the Hawaiian Islands.

ST78 16171 Dimensional Analysis of Ocean Thermal Energy Conversion Heat Exchangers, Final Report, July 1, 1976-June 30, 1977

Nelson, M.F.; Bock, A.E.
Naval Academy, Annapolis, MD
Avail:NTIS, N78-30665

This paper points out certain historical highlights and problems connected with development of electrical energy from deep-ocean thermal differences. Natural and economic factors which have focused attention on this type of energy development are mentioned, as well as areas of support by the National Science Foundation, the Energy Research and Development Administration, and the US Navy. Dimensional analysis is used to develop a list of dimensionless groups of factors having significance in OTEC (ocean thermal energy conversion) heat exchangers. Certain of these groups are then evaluated for a model and prototype OTEC-type heat exchanger using the same working fluid and experiencing the same working fluid flow rate per unit area. A discussion of the evaluation and conclusions complete the report.

ST78 16172 Economic Incentives for the Commercialization of OTEC: Ocean Thermal Energy Conversion

Nilles, J.M.; Washom, B.J.
Southern California Univ., Los Angeles, CA
4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33307 Jnl: Proc. of Conf. p. III-3 to III-16 Univ. of New Orleans

The needs and alternative means for federal intervention in the OTEC marketing process through regulatory influence and provision of various incentives in order to change the supply and demand portions of the market process are discussed. Consideration is given to reasons for preferential (or other) governmental support of OTEC and with the policy options open to government agencies in this connection.

ST78 16173 Net Energy Analysis of an Ocean Thermal Energy Conversion (OTEC) System

Perry, A.M.; Marland, G.; Zelby, L.W.
Inst. for Energy Analysis, Oak Ridge, TN
Avail:NTIS, N78-21652

The system used a Rankine power cycle with ammonia as the working fluid, and was based on essentially available technology. The plant would be located about 20 miles offshore and would produce 160 mw(e) of net electricity which would be carried ashore by underwater cable for transmission and distribution by conventional means. Evaporators and condensers for the ammonia power cycle were assumed to be made of titanium (for resistance to corrosion) although it was recognized that aluminum alloys, preferable from a cost standpoint, would prove to have acceptable corrosion resistance. Net electrical output of the plant at an assumed 90 percent plant factor was 1.26×10^9 kwh(e) per year.

ST78 16174 Development of Small-Scale Benign Sources of Energy in France

Probert, D.

Cranfield Inst. of Tech., Cranfield Beds, England

Avail:AIAA, A78-29291 Jrnl: Appl. Energy V 4:75-84 Jan. 1978

The paper reviews French approaches to harnessing "alternate" sources of energy. Some of these approaches are intended for use in developing countries. Topics considered include solar energy collection for domestic use, power release, direct conversion of solar energy, bioconversion, wind power, the sea as an energy source, and geothermal energy. Agencies involved with each research project are identified.

ST78 16175 A Methodology for OTEC Mission Analysis; Ocean Thermal Energy Conversion

Reid, R.W.Jr.

Aerospace Corp., El Segundo, CA

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33314 Jrnl: Proc. of Conf. p. III-67 to III-75 Univ. of New Orleans

The paper describes the OTECOST Computer Program which is intended to simulate closed-cycle OTEC power plant transmission system performance and cost for a wide variety of design concepts and siting conditions. The intention is to provide a uniform economic basis for comparing candidate generation delivery configurations on an overall system level. A flexible optimization capability is built into OTECOST to minimize the capital cost per net power delivered by varying the inlet and outlet turbine and heat exchanger temperatures.

ST78 16176 The Mist Flow OTEC Plant, Convective Lift to Achieve Hydraulic Head in Ocean Thermal Energy Conversion

Ridgway, S.L.

R and D Assoc., Marina Del Rey, CA

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33352 Jrnl: Proc. of Conf. p. VIII-37 to VIII-41 Univ. of New Orleans

The mist flow OTEC plant uses the steam evaporated from a spray of very fine warm water droplets to lift these droplets to substantial heights. The used steam is condensed at the end of the lift by a cold water spray. Gravitational potential energy is removed from the warm water in a conventional hydraulic turbine to provide the desired power output. The large evacuated duct in which the upward mist flow takes place is the major (\$360/kw) cost element of the system.

ST78 16177 Cost Comparison of Selected OTEC Power Plant Designs; Ocean Thermal Energy Conversion

Roberts, R.

Mitre Corp., Metrek Div., McLean, VA

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33305 Jrnl: Proc. of Conf. p. II-26 to II-37 Univ. of New Orleans

The OTEC design of the Applied Physics Laboratory (APL) has the objective of generating electric power to carry out the on-site production of selected energy intensive materials such as ammonia, aluminum, and hydrogen; the OTEC design of the Lockheed Missiles and Space Co. (LMSC) has the objective of delivering power ashore where it can be used in the electric distribution system or for onshore industry. The present paper reviews the cost differential of the APL and LMSC designs, indicating that the differences in design cost estimates arise from the mission and temperature differential selected. The less benign locations for the LMSC system lead to a heavier platform and additional costs for mooring.

ST78 16178 The OTEC Program at Carnegie-Mellon University: Heat Transfer Research and Power Cycle Transient Modeling, Ocean Thermal Energy Conversion

Rothfus, R.R.; Neuman, C.P.

Carnegie-Mellon Univ., Pittsburgh, PA

4th AOTEC Conf. March 22-24, 1977 New Orleans, LA

Avail:AIAA, A78-33335 Jrnl: Proc. of Conf. p. VI-55 to VI-70 Univ. of New Orleans

Results of experiments on falling film, fluted, vertical tube heat transfer surfaces are reported. It is found that flutes enhance the heat transfer coefficient far in excess of what might be expected from increased surface. Data for refrigerant 11 and ammonia are presented. Fine axial flutes on the water side seem to increase the heat transfer coefficient and the pressure drop in proportion to the increase of surface brought about by the flutes. It is concluded, therefore, that enhancement on the water side can result in a substantial reduction in heat transfer surface requirements and so also a reduction in volume for OTEC heat exchangers. Finally, analytical models for the transient behavior of OTEC power cycle components are exhibited. These models form the basis for control system design and operational strategies for OTEC.

ST78 16179 Compatibility Studies for the Ammonia-Titanium-Seawater System as Related to Ocean Thermal Energy Conversion

Saaski, E.W.; Owzarski, P.C.
Sigma Research, Inc., Richland, WA
4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33345 Jrnl: Proc. of Conf. p. VII-46 to VII-53 Univ. of New Orleans

The objective of this project is to determine if titanium is susceptible to stress corrosion cracking (SCC) in ammonia-seawater environments. The scope involves slow tensile strain experiments until failure of titanium rods in pure liquid ammonia, ammonia-water (0.025-1.0 percent), and ammonia-seawater (0.025-1.0 percent) mixtures. Results will be quantified by percent elongation and by microscopic analysis of SCC crack growth. Preliminary rapid strain experiments showed that the Ti specimens became highly anodic before failure and that repassivation occurred slowly, but at a somewhat faster rate in liquid ammonia-1-1/2 percent seawater than in anhydrous ammonia. Small amounts of gas appeared on the Ti specimen under strain in anhydrous ammonia. White precipitate appeared in liquid ammonia (0.27-5 percent)-seawater mixtures and in seawater (1-5 percent)-ammonia mixtures. The nature and possible role in fouling and corrosion of these precipitates is addressed.

ST78 16180 The External Flow Induced by an Ocean Thermal Energy Conversion (OTEC) Power Plant

Sundaram, T.R.; Sambuco, E.; Sinnarwalla, A.M.; Kapur, S.K.
Hydronautics, Inc., Laurel, MD
4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33319 Jrnl: Proc. of Conf. p. IV-42 to IV-49 Univ. of New Orleans

In connection with the operation of an OTEC power plant (OTECPP) about 60,000 gal/min of water per mw of capacity are withdrawn from both the surface and deeper layers of the ocean and discharged at intermediate levels. The processes involved and the effects produced by them change the stratification characteristics of the ocean water upon which the operation of an OTECPP is based. An investigation is, therefore, conducted concerning the external flow of an OTECPP. The results are presented of two classes of experiments, one involving the absence of ambient currents, and the other the absence of ambient stratification. It is found that recirculation will occur in spite of impeding factors when certain critical values of the governing similitude parameters are exceeded. The appropriate similitude parameters, as well as their critical values, are being delineated.

ST78 16181 OTEC Implementation Problems for Specific Missions; Ocean Thermal Energy Conversion

Tschupp, E.; Berkowitz, B.; Hausz, W.
GE Center for Advanced Studies, Washington, D.C.
4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33315 Jrnl: Proc. of Conf. p. III-76 to III-82 Univ. of New Orleans

The feasibility of four specific OTEC missions as commercial ventures is considered: (1) near-shore production of electric power delivered to shore via submarine cable, (2) offshore production of sea chemicals, (3) offshore production of aluminum, and (4) offshore production of fertilizers based on fixed nitrogen in the form of ammonia. The competitiveness of OTEC products in the marketplace is considered along the impacts of the technology and the political, institutional, and environmental factors associated with OTEC operations.

ST78 16182 Nitric Acid Cycle Process for Extracting Thermal Energy From Low-Level Heat Sources for Ocean Thermal Energy Conversion

Wakao, N.; Nojo, K.
Yokohama Nat'l Univ., Yokohama, Japan
Avail:AIAA, A78-35171 Jnl: Nature, V 273:25-27 May 4, 1978

Attention is given to a nitric acid cycle process for recovering thermal energy from a low-level heat source. The process is based on the heat generated when nitric acid and water are mixed. Nitric acid forms a maximum boiling point azeotrope with water. The azeotrope at 9 mm HG is approximately 65 percent nitric acid and boils at 25 C. At this pressure, water boils at 9.7 C. The mixture of nitric acid and water is separated into 65 percent nitric acid and water in distillation columns. Warm (28 C) surface seawater is used as the heating medium and cold seawater (5-7 C) as the cooling medium. Instead of a single distillation tower, two or more columns are operated at different low pressures. In calculating heat recovery, heat losses are not assumed in the transfer lines or mixing tanks. A 4 percent overall useful heat gain is estimated.

ST78 16183 Potential of Open-Cycle OTEC, A General Survey; Ocean Thermal Energy Conversion

Watt, A.D.; Mathews, F.S.; Hathaway, R.E.
Colorado School of Mines, Golden, CO
4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
Avail:AIAA, A78-33347 Jnl: Proc. of Conf. p. VIII-3 to VIII-11 Univ. of New Orleans

In an open-cycle ocean thermal energy conversion (OTEC) system warm surface water is introduced into a low-pressure chamber where it flashes to steam, passes through a turbine, and condenses in a low-pressure chamber where the spent steam comes in direct contact with cold water from deep in the ocean. The noncondensable gases from the ocean water which accumulate in the condenser must be removed. Structure sizes and material requirements for the evaporator, turbine generator system, and condenser are examined and the cost factor is determined. A computer program was developed in which the cost versus performance characteristics of each of the components are related in a system model. A comparison of major subsystem characteristics and costs is developed as the various input and operating parameters are varied. On the basis of preliminary results, it appears that major efforts at cost reduction should be centered on the turbine/generator, the evaporator/condenser, and the cold water pipe.

ST78 16184 Reflections on the Energy Wars: Solar Vs. Nuclear Power

Weinberg, A.M.
ORNL, Oak Ridge, TN
Avail:AIAA, A78-30297 Jnl: Am. Scientist, V 66:153-158 March-April 1978

The controversy over solar vs. nuclear energy is examined, noting that there is irrationality on both sides, i.e., the nuclear power advocates tend to scoff at the practicality of solar power, while the solar advocates often exaggerate the dangers of nuclear power. It is pointed out that the generation of electricity from nuclear power plants is far cheaper at present than would be the comparable power derived from small, widely dispersed solar generators. Attention is given to the difficulty of electrical storage in solar power facilities, but also to the possibility of catastrophic accident from nuclear plants. The author advocates a cautious use of nuclear-generated electricity for the short run, with increasing dependence on solar power once a more efficient solar technology comes on-line.

ST78 16185 Axisymmetrical Critical Withdrawal of a Rotating Fluid-Swirling-Outflow From Cylindrical Container Applied to Ocean Thermal Power Plants

Whitehead, J.A.Jr.; Porter, D.L.
Woods Hole Oceanographic Inst., Woods Hole, MA
Avail:AIAA, A78-32527 Jnl: Dynamics of Atmos. and Oceans V 2:1-18 Dec. 1977

The reported studies of flows in a rotating frame have been conducted for two reasons, including a possible application to geophysical problems and the desirability to make experimental observations of a rotating critical flow in the limit of rapid rotation. The problem of the flow of a uniform density fluid which is introduced at one radius and critically withdrawn at another radius in a cylindrical container is formulated and solved. The theoretical results are compared with laboratory measurements. Good agreement between experiment and theory is obtained in all cases except one, which involves a parameter range with an instability to the axisymmetric state. Attention is also given to some laboratory observations of nonaxisymmetric withdrawal and a possible application of the results of the investigation to ocean thermal difference power plants.

ST78 16186 Monthly Assessment of Temperature Resource for Three Potential OTEC Sites

Wolff, P.M.; Lewis, L.
 Ocean Data Systems, Inc., Monterey, CA
 4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
 Avail:AIAA, A78-33321 Jnl: Proc. of Conf. p. IV-57 to IV-60 Univ. of New Orleans

A monthly assessment is made of the temperature resources for three potential OTEC sites. The regions are located near the Hawaiian Islands, south of Puerto Rico, and in the Gulf of Mexico. Deep soundings are sorted in one degree latitude-longitude squares on a monthly basis. Sea surface temperature, shallow soundings, and both shallow and deep casts are analyzed. The bathymetry of each area is studied to determine the necessary depths for mooring cables. Further research is currently being planned in a number of other areas.

ST78 16187 The Foam OTEC System, A Proposed Alternative to the Closed-Cycle OTEC System

Zener, C.
 Carnegie-Mellon Univ., Pittsburgh, PA
 4th AOTEC Conf. March 22-24, 1977 New Orleans, LA
 Avail:AIAA, A78-33350 Jnl: Proc. of Conf. p. VIII-27 to VIII-29 Univ. of New Orleans

Traditionally, ocean thermal energy conversion (OTEC) platforms have operated either on the D'Arsonval closed-cycle or the Claude open-cycle, both of which use a single-phase working fluid. This paper presents a new concept for OTEC, whereby a two-phase foam system is used to move the input warm water downward into the two-phase region, where the liquid and vapor phases are closely coupled. Advantages of the system include the absence of heat exchangers (thereby reducing the possibility of fouling), no warm water exhaust, and greater (by a factor of 5 to 10) power output per unit of warm water input. Attention is given to the structural parameters of the foam itself.

ST78 16188 Sea Water: The Energy Elixir

Zimmerman, M.D.
 Jnl: Mach. Des. V 49:20-22, 24-26, N16 July 7, 1977

Engineers around the world are working to unleash the vast amount of energy stored in the oceans. Under consideration are a number of Jules Verne-like schemes that include seawater batteries, floating wave generators, shore-based tidal dams, and deepwater turbine platforms. The ideas may seem far-fetched, but they may well be the forerunners of practical sea-based hardware that will help fill the world's energy needs.

17,000 WIND POWER

ST78 17129 Criteria for the Manufacture and Operation of Wind Power Installations With Power up to 10 KW

4th EFW Mtg., June 7,8, 1977 Bremen, W. Germany
 Avail:AIAA, A78-28573 Jrnl: Proc. of Mtg., Rept., p. 353-362 Deutsche Gesellschaft
 Fuer Sonnenenergie, Munich, W. Germany In German

Several topics relevant to the design of wind power installations are surveyed. Inherent limitations in power generation are considered, safety factors in blade construction and to protect against damage from high winds are examined, and the size, output, and construction of generators are briefly reviewed. Characteristics of batteries and transformers are also reported.

ST78 17130 Fatigue Load Spectra for Upwind and Downwind Rotors

Andrews, J.S.
 Boeing Co., Seattle, WA
 Avail:NTIS, N78-19635 NASA, Lewis, Wind Turbine Structural Div.

Effect of both alternating and mean load on the fatigue life of an upwind and downwind MOD-2 wind turbine system is presented. It was shown that the fatigue damage varies as the product of the stress range cubed and the maximum stress. Hence, the alternating flapwise load caused by tower shadow and wind gradient is an important factor in determining rotor blade life.

ST78 17131 Engineering of Wind Energy Systems

Banas, J.F.; Sullivan, W.N.
 Sandia Labs., Albuquerque, NM
 Avail:AIAA, A78-32423 Jrnl: Wind Tech. J., V 1:23-31 1977, Spring

This report addresses the engineering of wind energy systems from the point of view of component selection and performance assessment. Combinations of two load types (variable and constant speed) and three turbine types connected by a fixed-gear-ratio transmission constitute the various systems investigated. The three turbine types result from introducing the notions of nested, unnested, and hybrid power coefficients suggested by current performance characteristics of American multi-blade, Darrieus, and Darrieus/Savonius turbines. The engineering problems associated with these systems are discussed qualitatively, emphasizing the nature, magnitude, and variability of the problems.

ST78 17132 Blade Design and Fabrication; 17-Meter VAWT, Vertical Axis Wind Turbine

Barzda, J.J.
 Kaman Aerospace Corp., Bloomfield, CT
 Avail:AIAA, A78-32422 Jrnl: Wind Tech. J., V 1:17-22 Spring, 1977

Sandia Laboratories, Albuquerque, New Mexico, is erecting an experimental 17-meter vertical axis wind turbine (VAWT) power generating system. The subsystems are now being fabricated. The subject of this paper is the design and fabrication of the turbine rotor blades. The rotor will have three blades, stiffened with support struts. The design criteria, structural design, supporting engineering analysis, and fabrication methods are discussed.

ST78 17133 Measurement Program of the Dutch Experimental Vertical-Axis Wind Turbine

Bolt, J.B.D.H.
 Fokker-VFW, Schiphol Airport, Netherlands
 4th EFW Mtg., June 7,8, 1977 Bremen, W. Germany
 Avail:AIAA, A78-28561 Jrnl: Rept. of Mtg., p. 125-132E Deutsche Gesellschaft Fuer
 Sonnenenergie, Munich, W. Germany In German

The main design criteria met by the experimental Darrieus (vertical-axis) rotor for the Dutch Wind Energy Research Program are enunciated. The two-bladed rotor was made of plastic, the diameter and composition of the blades being constant over their whole length. The blades were attached to the vertical axis in such a way that the stiffness of the joint could be later adjusted in order to accommodate possibly three blades and variable-diameter blades. Parameters measured in the experiments included rotor aerodynamic efficiency and its dependence on wind conditions, dynamic behavior of the whole turbine,

static and dynamic loading of the blade roots during normal running and transient conditions, efficiency at constant and variable RPM number, stagnation region parameters and strength of vorticity behind the turbine. A diagram showing the installation and location of the measuring instruments is given.

ST78 17134 The Coupling of Solar Energy Utilization and Wind Energy Utilization

Bossel, U.

Aerodynamische Versuchsanstalt, Goettingen, W. Germany

4th EFW Mtg., June 7,8, 1977 Bremen, W. Germany

Avail:AIAA, A78-28568 Jnl: Rept. of Mtg., p. 275-303 Deutsche Gesellschaft Fuer
Sonnenenergie, Munich, W. Germany In German

The use of a combined solar energy and wind energy plant for space heating is described. In arguing for the feasibility of the combined solar-wind system, the complementary availability of solar radiation and wind energy over the course of a year or a single day is assessed. A sample plant involving a 10-kw wind energy converter, a power storage system, and a solar energy collector is considered.

ST78 17135 Comparison of Blade Loads of Fixed and Free Yawing Wind Turbine

Cheney, M.C.; Bielawa, R.L.

United Tech. Res. Center, E. Hartford, CT

Avail:NTIS, N78-19637 NASA, Lewis Res. Center, Wind Turbine Structural Dyn. p. 237-242

The self-regulating composite bearingless wind turbine utilizes an automatic pitch control concept and a completely unrestrained yawing degree of freedom. Aerodynamic moments caused by skewed flow provide the control to align the wind turbine with the wind. Model tests demonstrated the feasibility of the concept and analytical studies showed the free system to experience lower blade loads compared to the fixed system.

ST78 17136 Windmill Power for City People, Final Report

Christianson, M.

Energy Task Force, Inc., New York, NY

Avail:NTIS, N78-21654

Findings show that the energy produced from the windmill is an importance renewable energy resource which can be used in most urban areas and which reduces dependency on utility companies. A brief history of the windmill's origin, design, and installation procedures are outlined. Also included are comparisons of energy savings of the literature, resources, a wind speed and direction map, structural engineering calculations, and an explanation of wind forces on windmills.

ST78 17137 Wind Energy Mission Analysis, Final Report

Coty, U.A.

Lockheed-California Co., ERDA, Burbank, CA

Avail:NTIS, SAN/1075-1/1 608 p. Sept. 1976

Maps of wind power densities are presented covering the United States and territories. Each region is assessed in terms of available wind power, its distribution over the land, and its frequency, deviation, and strength. A matrix of energy users and their applications of wind energy conversion systems is assembled and evaluated to select those combinations which have the highest potential in terms of nationwide impact. The high potential applications are analyzed in depth to determine degree of market penetration, performance and cost goals, marketing channels, incentives to implementation, and institutional constraints. An initial assessment of public acceptance was performed during the course of the study which is analyzed and reported. Widely varying scenarios are postulated to develop extreme, yet possible, limits of implementation rates. The effects of these implementation rates are determined as they pertain to production rates, supply of critical materials, land usage, capital requirements, environmental pollution, electrical energy generated, fossil fuel saved, balance of trade, net flow of free energy, and energy payback time.

ST78 17138 Estimate of the Interaction of a Limited Array of Windmills

Crafoord, C.

Stockholm Univ., Inst. of Meteorol., Stockholm, Sweden

Avail:NTIS, MISU/IMI-DM-16 43 p. Nov. 1975 US Sales Only

A simple model has been set up to estimate the interaction of a limited array of windmills, following the ideas presented by Templin (1974). Using logarithmic wind profiles, the increment of roughness parameter as an infinite array of windmills is added to an already rough surface, is calculated by a method of superposition of surface stress and windmill drag. The obtained logarithmic profiles are used to calculate the relative power of a single windmill in an unlimited array. These values are then used as limiting values for the relative power of a windmill unit in a limited array, using a simple continuity model of energy flow. Various examples are given to illustrate the efficiency of different windmill units and array sizes. Examples are also given for a tentative 100-mw group station using different rated power units.

ST78 17139 Wind Energy Conversion; Horizontal-Axis Machines

Doerner, H.

Stuttgart Universitaet, Stuttgart, W. Germany

Avail:AIAA, A78-28559 Deutsche Gesellschaft Fuer Sonnenenergie p. 81-97 In German
Munich, W. Germany

The paper discusses the various design options available for horizontal-axis wind energy converters. First the general requirements on such systems are enunciated, such as easy service accessibility, climatic stability of the components, modularity, and low cost. Three size classes are characterized, corresponding to different user needs. The design options considered are those for the generator, the drive system, tower construction, and control. Comparisons are made between the performance of the free-running turbine with the horizontal axis, the shrouded turbine, the Savonius rotor, and the vertical-axis (Darrieus) rotor, from which the superiority of the free-running machine with horizontal axis, in terms of the ratio of wind-exposed surface area to total material surface area, is revealed.

ST78 17140 Development of a Wind Energy Site Selection Methodology, Progress Report, May 3-Dec. 3, 1976

Freeman, B.E.; Patnaik, P.C.; Phillips, G.T.

Sci. Applications, Inc., La Jolla, CA

Avail:NTIS, RLO/2440-76/4 152 p. 1976

The components of the site selection methodology, and the method of Empirical orthogonal Eigenfunctions for the identification of recurrent meteorological patterns in the climatological data are described. Several faster meteorological computer codes are compared. The further development and testing of the primitive equation models (the SIGMET family of codes) are described. This consists of developments which will permit calculations to be performed more rapidly (through partial implicitization) and more accurately (through improved physical models).

ST78 17141 Wind Energy Program of the Danish Government and the Danish Electric Power Concerns

Grastrup, H.

Elsam, Fredericia, Denmark

4th EFW Mtg., Bremen, W. Germany

June 7,8, 1977

Avail:AIAA, A78-28554 Deutsche Gesellschaft Fuer Sonnenenergie p. 23-26 In German
Munich, W. Germany

Projects called for the Danish Government Wind Energy Study Program are enunciated. These include the reoperation of the Gedser turbine, a 200-kw three-bladed machine that operated successfully without serious failure in the years 1957-1967. Its performance data will be analyzed and compared with data on recent American designs. Major effort will be concentrated to develop and build one or two larger facilities and to connect them with the common grid. The machines envisaged are of the propeller-turbine type with propeller diameter in the range 35-45 m, delivering 400-600 kw.

ST78 17142 Possibilities and Prospects for Wind Energy Utilization

Huetter, U.

Stuttgart, Universitaet, Stuttgart, W. Germany

4th EFW Mtg., June 7,8, 1977 Bremen, W. Germany

Avail:AIAA, A78-28552 Jnl: Proc. of Mtg., p. 1-15 Deutsche Gesellschaft Fuer
Sonnenenergie, In German Munich, W. Germany

Some data on the available wind power in western European countries are presented. The possibility of using storage devices for smoothing the fluctuations in available wind energy is mentioned. A diagram is presented and discussed, showing the possible operating regions of the rotor elements in the turbine state, vortex state, and propeller state. A breakdown of the costs and masses with respect to the system groups of a complete wind energy system is given.

ST78 17143 The Swedish Wind Energy Programme

Hugosson, S.

4th EFW Mtg., June 7,8, 1977 Bremen, W. Germany

Avail:AIAA, A78-28555 Jnl: Proc. of Mtg., p. 27-38, Deutsche Gesellschaft Fuer
Sonnenenergie Munich, W. Germany

Prospects and plans for wind energy development in Sweden are discussed. Most efforts will be devoted to developing large wind power units connected to the national grid. Most attention will be devoted to the horizontal-axis propeller-type machine. Wind energy prospecting program will consist of a survey of winds in the 50 to 200 m-height level. The wind power experimental unit will be equipped with an 18-m two-bladed aluminum turbine and a 50-kw induction generator. The height of the hub will be 25 m and the tower will be made of prestressed concrete. The system will be remotely controlled by minicomputer.

ST78 17144 Three-Phase Induction Motor Loads on a Variable Frequency Wind Electric Generator

Johnson, G.L.; Walker, H.S.

Kansas State Univ. of Agriculture and Appl. Sci., Manhattan, KS

Avail:AIAA, A78-32050 Jnl: Wind Engng., V 1:268-276 N4 1977

The influence of three-phase induction motor loads on a variable-frequency wind electric generator is evaluated. An asynchronous wind electric generator is simulated by a DC motor driving an AC alternator. The output powers an air conditioning unit having a three-phase induction motor. It is found that the motors start and operate well for any frequency if the voltage is proportional to the frequency, and that the motor starts when the frequency is between one and three Hz. It has been noted that a wind turbine may be used to drive a permanent magnet alternator connected to such three-phase induction motors. In long periods of little wind the heat pump may be driven by utility power.

ST78 17145 Winds and Wind System Performance Book

Justus, C.G.

Georgia Inst. of Tech., Atlanta, GA

Avail:AIAA, A78-32074 120. p. 1978 NSF and ERDA, Franklin Inst. Press, Philadelphia,
Philadelphia, PA

Wind characteristics are discussed with reference to evaluation of wind energy conversion systems performance. Weather data sources and measurement methods are considered, and techniques applicable to large-scale (e.g., large multi-unit arrays) and to small-scale (e.g., simple power regression relations) use are described. Calculation of output power is explained; factors relevant to system design, siting, and operation are taken into account; and special requirements necessary for performance are reported.

ST78 17146 How Wind Variability Affects the Potential Power Available From Wind Generators

Konigsberg, A.S.

New York State Univ., New Paltz, NY

Avail:AIAA, A78-32504 Jnl: Wind Tech. J., V 1:8-10 Fall 1977

An analysis is presented to show that two different areas having the same average wind could produce significantly different amounts of power from comparable wind generator systems. Information about average wind in the area is not sufficient for prediction because of topographic and similar features. Even knowledge of the average wind speed at

the precise location under consideration does not guarantee adequate predictions. The analysis explained here permits greater accuracy by taking wind variability into account. Detailed analysis of wind speed at all potential sites is recommended.

ST78 17147 Renewable Energy Sources and Storage; Wind Power in Britain

Leicester, R.J.; Newman, V.G.; Wright, J.K.

Central Electricity Generating Board, Planning Dept., London, England

Avail:AIAA, A78-32249 Jnl: Nature, V 272:518-521 April 6, 1978

Studies conducted in Britain on the feasibility of large-scale reliance on soft energy, e.g., wind, solar, and wave, have led to the conclusion that such sources cannot now be considered replacements for fossil fuels and nuclear power because of climatic variations. In other words, difficulty in storing energy from soft sources necessitates that conventional sources tied into the existing electrical grid, still supply the bulk of Britain's power.

ST78 17148 Recent Developments in Wind Turbines

Ljungstrom, O.

4th EFW Mtg., June 7,8, 1977 Bremen, W. Germany

Avail:AIAA, A78-28563 Jnl: Proc. of Mtg., p. 165-186 Deutsche Gesellschaft Fuer
Sonnenenergie, Munich, W. Germany In German

Results of some systems studies on wind power development in Sweden are presented and problems regarding blade design, size effects, material choice, weight, and costs are discussed. It is shown that increasing the installation size from 1 mw to 5 mw actually has the effect of a 50 percent reduction in required ground area. A study of the dependence of system investment on power output in the range 100 kw to 10 mw shows that when investments in ground, roads, power circuits, and grid connection are taken into account the minimum system cost tends toward large installations, about 2 to 5 mw.

ST78 17149 Maximum Wind Energy Utilization by Means of a Single-Unit Wind Turbine

Mayer-Schwinning, W.

4th EFW Mtg., June 7,8, 1977 Bremen, W. Germany

Avail:AIAA, A78-28572 Jnl: Proc. of Mtg., p. 341-344 Deutsche Gesellschaft Fuer
Sonnenenergie Munich, W. Germany In German

Factors relevant to the optimization of wind turbine performance are surveyed, and parameters for two wind turbine blades are presented. Four heights are considered for these height-dependent parameters which define the theoretical yields and energies at average wind velocities and the optimum net yield and maximum energy output. Multi-unit turbine arrangements, whose energy ratings are equal to the sum of the component unit energy ratings, are examined.

ST78 17150 Wind-Wall: An Integrated Wind/Solar System

McVeigh, J.C.; Pontin, G.W.W.

Brighton Polytech. Engng.

Jnl: Wind Engng., V 1:150-158 N2 1977

An approach is described to the problem of providing space and water heating to a group of local authority houses in the south of England, where there is moderate annual mean wind speed, 6.0 ms^{-1} , and an annual solar insolation of about 1000 kWhm^{-2} on a south-facing inclined slope. The windmill system is grouped in a "wind-wall," a new concept with fixed ducted horizontal-axis bi-directional windmills based on a 2-MC cube.

ST78 17151 Fully Automatic Wind Power Plant 125/220 V 4 KVA

Mirus, G.I.

Winson GMBH and Co., Eckernfoerde, W. Germany

4th EFW Mtg., June 7,8, 1977 Bremen, W. Germany

Avail:AIAA, A78-28571 Jnl: Proc. of Mtg. p. 335-339 Deutsche Gesellschaft Fuer
Sonnenenergie Munich, W. Germany In German

A fully automatic wind power plant is discussed with attention to its feathered propeller blades, generator, circuitry, and automated steering. One of the functions of the automatic steering mechanism is to prevent damage from storms and the stability required of windmills exposed to higher-than-normal winds is considered. The role of automatic switches and load increments is explained.

ST78 17152 Novel Wind Turbine Invention of a Viennese Engineer, "Fan Principle" Yields Several-fold the Current Effective Power

Oppolzer, G.
4th EFW Mtg., June 7,8, 1977 Bremen, W. Germany
Avail:AIAA, A78-28566 Jrnl: Proc. of Mtg., p. 228B-228E Deutsche Gesellschaft
Fuer Sonnenenergie Munich, W. Germany In German

The general idea of a new type of wind turbine is presented. The machine consists of two wind wheels rotating in a horizontal plane. The wheels are mounted on one axis at an angle to each other, so that from one direction they appear to interlock while on the opposite side they are spread wide apart, offering maximum surface to the wind. The machine operates at any wind speed and can start up under load. Performance data provided give a 6.3 kw output at wind speed of 7 m/sec and 55.4 kw at 15 m/sec for a machine having a rotor diameter of 11 m.

ST78 17153 Comparison of Computer Codes for Calculating Dynamic Loads in Wind Turbines

Spera, D.A.
NASA, Lewis, Cleveland, OH
Avail:NTIS, N78-19617 Jrnl: Wind Turbine Structural Dyn. p. 1-13

The development of computer codes for calculating dynamic loads in horizontal-axis wind turbines was examined and a brief overview of each code was given. The performance of individual codes was compared against two sets of test data measured on a 100 kw MOD-0 wind turbine. All codes are aerolastic and include loads which are gravitational, inertial, and aerodynamic in origin.

ST78 17154 How to Build Wind Wheels: Construction and Calculation---German Book

Von Koenig, F.
Munich, Udo Pfrommer Verlag GMBH, 141 p.
Avail:AIAA, A78-32075 1977 In German \$17.45

Wind energy is now considered sufficiently practical to generate enough electric power to supply even large-scale local commercial, industrial, and domestic enterprises. This book reviews some of the basic mechanical principles of wind turbines and compares various suggestions for the design of modern wind wheels used to generate electricity. An American turbine, similar to the kind which has been traditionally used in the mid-west, is presented as an illustration of efficiency using proven technology.

ST78 17155 A Simulation Model for Wind Energy Storage Systems, Volume 1, Technical Report Final Report

Warren, A.W.; Edsinger, R.W.; Chan, Y.K.
Boeing Computer Services, Inc. Seattle, WA
Avail:NTIS, N78-20802

A comprehensive computer program for the modeling of wind energy and storage systems utilizing any combination of five types of storage (pumped hydro, battery, thermal, flywheel, and pneumatic) was developed. The level of detail of simulation model for wind energy storage (SIMWEST) is consistent with a role of evaluating the economic feasibility as well as the general performance of wind energy systems. The software package consists of two basic programs and a library of system, environmental, and load components. The first program is a precompiler which generates computer models (in Fortran) of complex wind source storage application systems, from user specifications using the respective library components. The second program provides the techno-economic system analysis with the respective I/O, the integration of systems dynamics, and the iteration for conveyance of variables. SIMWEST program, as described, runs on the Univac 1100 series computers.

ST78 17156 A Simulation Model for Wind Energy Storage Systems, Volume 2, Operation Manual Final Report

Warren, A.W.; Edsinger, R.W.; Burroughs, J.D.
Boeing Computer Services, Inc. Seattle, WA
Avail:NTIS, N78-20803

A comprehensive computer program (SIMWEST) developed for the modeling of wind energy storage systems utilizing any combination of five types of storage (pumped hydro, battery, thermal, flywheel, and pneumatic) is described. Features of the program include a precompiler which generates computer models (in Fortran) of complex wind source-storage-

application systems, from user specifications using the respective library components; a program which provides the techno-economic system analysis with the respective I/O the integration of system dynamics, and the iteration for conveyance of variables; and capability to evaluate economic feasibility as well as general performance of wind energy systems. The SIMWEST Operational Manual is presented and the usage of the SIMWEST program and the design of the library components are described. A number of example simulations intended to familiarize the user with the program's operation is given along with a listing of each SIMWEST library subroutine.

ST78 17157 A Simulation Model for Wind Energy Storage Systems, Volume 3, Program Descriptions Final Report

Warren, A.W.; Edsinger, R.W.; Burroughs, J.D.
Boeing Computer Services, Inc. Seattle, WA
Avail:NTIS, N78-20804

Program descriptions, flow charts, and program listings for the SIMWEST model generation program, the simulation program, the file maintenance program, and the printer plotter program are given.

ST78 17158 Harnessing the Wind; Review of Wind Turbine Machines

Yen, J.T.
Grumman Aerospace Corp. Bethpage, NY
Avail:AIAA, A78-29222 Jrnl: IEEE Spectrum V 15:42-47 March 1978

Conventional wind machines such as the propeller and Darrieus types are limited by areas having a low intensity of energy flux or where the wind has unpredictable fluctuations. It has been suggested that sizable storage devices may offset some of these problems. Limitations are also encountered with wind farms, i.e., clusters of wind machines. These include the need for considerable spacing and the possibility of injury resulting from blade failure. Various alternatives to these wind machines are being explored at the present such as the Phi-Darrieus, Giromill, and Madaras systems. Another possible alternative is the Tornado wind-energy system where a large amount of wind is collected by a stationary omnidirectional tower, forming a vortex within the tower. This system can use both low and high-grade heat energies, does not require cooling water, and avoids the chemical corrosion of the turbine blades.

18,000 BIOMASS AND PHOTOCHEMICAL

ST78 18076 A Wealth of Waste; A Shortage of Energy; Organic Wastes for Fuel Conversion in US

Anderson, L.L.

Univ. of Utah, Salt Lake City, UT

Avail:AIAA, A78-27802 Jnl: Fuels From Waste, p. 1-16 Academic Press, Inc., New York, NY 1977

Organic wastes currently available for transformation to fuels in the US are tabulated; attention is given to manure, agricultural crop wastes, urban refuse, sewage solids, industrial process wastes and logging and wood manufacturing residues. Heating values of the organic wastes, as well as the availability of large quantities of the waste materials in the vicinity of potential markets, determine the feasibility of the transformation to fuel. Advantages of using organic wastes for fuels include low pollutant levels resulting from the limited sulfur and ash contents of the wastes.

ST78 18077 The Production of Oil From Wood Waste

Appell, H.R.

US Dept. of Energy, Pittsburgh Energy Res. Center, Pittsburgh, PA

Avail:AIAA, A78-27809 Jnl: Fuels From Waste p. 121-140 Academic Press, Inc. New York, NY 1977

Heavy oil or a bitumen-like material may be produced through processing of wood wastes with water, sodium carbonate, and a gas rich in carbon monoxide at temperatures between 250 and 400 C and pressures of 1500 to 3500 PSIG. A pilot plant has been constructed to test this procedure on a commercial scale; the capacity of the plant is one ton of wood chips per day. The BTU content of oils and bitumens produced by the process is in the range of 13,000 to 17,000 BTU/lb, i.e., less than about 80 percent of the BTU content of a petroleum oil.

ST78 18078 Investigation of Converting the Product of Coal Gasification to Methane by the Action of Microorganisms, Phase I Quarterly Report, Sept. 1-Dec. 1, 1976

Augenstein, D.C.; Wise, D.L.

Dynatech R/D Co., Cambridge, MA

Avail:NTIS, N78-21319

The principal experimental objectives were to increase productivity through thermophilic operation in conjunction with recycle; to demonstrate high pressure, high-rate thermophilic operation with recycle; and to demonstrate the practical biological shift conversion of carbon monoxide. Thermophilic operation with recycle has resulted in the highest productivities obtained to date. High productivities were delivered in thermophilic pressure fermentations to 120 PSIG with recycle. Encouragingly rapid rates of CO conversion were obtained in initial trials utilizing a new organism and medium; an initial shift rate and hydrogen productivity were attained. In trials to establish the sensitivity of the thermophilic culture to hydrogen sulfide, no inhibition of culture productivity was seen at hydrogen sulfide concentrations as high as 10 percent in the test gas mix.

ST78 18079 Potential of Arid Zone Vegetation as a Source of Substrates

Bassham, J.A.

Univ. of California, Lawrence Berkeley Lab., Berkeley, CA

Avail:NTIS, LBL-7214 Nov. 1977

Three aspects of the potential of vegetation in arid zones as a source of substrates are discussed. The first includes the limitations on efficiency of conversion of solar energy to the stored chemical energy of biomass in green plants, and the subsequent biochemical pathways of carbon dioxide fixation and biosynthesis. Second is the potential of plants endogenous to arid zones. Finally, the use of covered agriculture or controlled environmental agriculture (CEA) is considered both in its present form and in terms of possible extension to the large-scale production of stable crops.

ST78 18080 Photochemical Conversion and Storage of Solar Energy

Bolton, J.R.

Univ. of W. Ontario, London, Ontario

Jrnl: J. Solid State Chem., V 22:3-8 N1 Sept. 1977

The possibilities for the photochemical storage of solar energy are examined from the standpoint of maximum efficiency and mechanism. Loss factors are considered for a general endergonic photochemical reaction and it is concluded that a realistic maximum solar energy storage efficiency for any photochemical system is 15 to 16 percent. The natural process of photochemical solar energy storage, namely, photosynthesis, is analyzed and it is found that the maximum solar energy storage efficiency of photosynthesis is 9.5 ± 0.8 percent. Kinetic and thermodynamic limitations on a photochemical energy storage process are identified and it is shown that the desirable production of hydrogen and oxygen from water probably cannot be sensitized with visible light if only one photochemical step is employed.

ST78 18081 Photochemical Storage of Solar Energy

Bolton, J.R.

Western Ontario Univ., London, Canada

Avail:AIAA, A78-28170 Jrnl: Solar Energy, V 20:181-183 N2 1978

Artificial systems are considered the only feasible method for the photochemical storage of solar energy. This paper suggests that the design of such systems be based on our knowledge of the mechanism of photosynthesis. Basic principles of photochemical storage are outlined using daylight as a light source. Attention is given to transmission and absorption coefficients, and to the calculation of energy loss as certain threshold barriers in the photosynthetic process are surmounted. A scheme is proposed which could use the photochemical decomposition of water into hydrogen and oxygen by employing a photochemically reducing dye in a coupled system. The hydrogen would then be stored to be used for efficient pollution-free fuel as needed.

ST78 18082 Fuels and Chemicals From Crops

Bungay, H.R.; Ward, R.F.

US Dept. of Energy, Div. of Solar Energy, Washington, D.C.

Avail:AIAA, A78-27808 Jrnl: Fuels from Waste, p. 105-120 1977 Academic Press, Inc.
New York, NY

Biomass conversion processes designed to provide fuels and chemicals in the long term are discussed; conversion processes for both aquatic and terrestrial plants are considered. Products of biomass conversion include synthesis gas, ammonia, methanol, formaldehyde, alcohols, aromatics, ethylene, heterocyclics, gum naval stores, and cellulose derivatives. Anaerobic digestion, pyrolysis, gasification, fermentation processes, and the production of hydrogen by biophotolysis are the chief processing methods applicable to biomass conversion.

ST78 18083 Solar Biomass Energy, An Overview of US Potential

Burwell, C.C.

ORNL, Oak Ridge, TN

Avail:AIAA, A78-26967 Jrnl: Science, V 199:1041-1048 March 10, 1978

The article reviews the US potential for using solar biomass energy, noting individual land use projects in terms of potential contributions to biomass fuel. These include cropland and forest land production, urban areas, noncommercial forests, pastures and ranges, and idle cropland. Estimates are made for gross and collectible net energy yields. The concept of intensive tree farming and the role of specialty crops in energy production are discussed. Current agricultural markets for cropland production are identified and consideration is given to exports and livestock production. Various environmental considerations relating to the production and use of biomass energy are outlined such as stream pollution, loss of productive lands, and atmospheric pollution. Possibilities for increasing photosynthesis efficiency are proposed.

ST78 18084 Application of Chemical Engineering to Large-Scale Solar Energy

Chubb, T.A.; Nemecek, J.J.; Simmons, D.E.

US Navy, E.O. Hulburt Center for Space Res., Washington, D.C.

Avail:AIAA, A78-30265 Jrnl: Solar Energy V 20:219-224 N3 1978

The SOLCHEM power station concept is described. The components include an energy collector field containing dispersed solar furnace heated chemical reactors, an assemblance of demand-responsive energy storage boiler tanks in which large quantities of energy are stored as latent heat-of-fusion, and a conventional dry-steam turboelectric generating facility. A eutectic salt is used for energy storage and heat pipe boilers provide on-demand power plant steam. An experimental study comparing SO_3 and steam-methane working fluids is reported.

ST78 18085 Photoredox Reactions of Metal Ions for Photochemical Solar Energy Conversion

Davis, D.D.; King, G.K.; Stevenson, K.L.; Birnbaum, E.R.; Hageman, J.H.
NMSU, Las Cruces, NM
Jrnl: J. Solid State Chem. V 22:63-70 N1 Sept. 1977

Solar energy conversion to chemical potential energy is thermodynamically feasible by many routes. One possible route is the photochemical reaction of metal ions in water to produce hydrogen and an oxidizer. The photooxidation of several low-valent transition metal ions, including europium(II), vanadium(II), and copper(I) complexes, proceeds according to the given equation. This reaction proceeds in visible light with a minimum of photochemical complications for Eu(II) and Cu(I) salts, and since the oxidation of copper(I) halo-complexes is endergic and thus potentially useful for energy storage, the mechanism of photooxidation is studied. The product quantum yield is strongly affected by the acidity, irradiation wavelength, and H-atom scavengers. Photoredox reactions of a number of metal ions and the requirements for using such in a solar energy scheme are discussed.

ST78 18086 Solar Heat Storage Using Chemical Reactions

Ervin, G.
Rockwell Int. Corp., Canoga Park, CA
Jrnl: J. Solid State Chem. V 22:51-61 N1 Sept. 1977

As an alternative to storage of sensible heat in liquids or solids or as latent heat of fusion, heat storage by means of reversible chemical reactions is under investigation. By this method, a chemical is separated into two components by heating and heat absorption, following which the components are stored in separate vessels and are recombined to generate heat when it is needed. The attractiveness of this concept of heat storage is not only higher energy density, but the capability to store energy as long as desired at ambient temperature, the option of transporting the chemicals to generate heat at another location, and the high temperatures characteristic of some of the reactions which result in high efficiency when the stored heat is used to generate electricity. The problems to be solved and potential applications are illustrated by the results of work in progress on $\text{Mg}(\text{OH})_2$ and $\text{Ca}(\text{OH})_2$ decomposition.

ST78 18087 Synthetic Fuel Production From Solid Wastes, Final Report

Feber, R.C.; Antal, M.J.
LASL, Los Alamos, NM
Avail:NTIS, PB-272423 Sept. 1977

The work described in this report has two objectives: first, to evaluate potential catalysts for the commercial practice of the gasification of chars produced by the pyrolysis of municipal or industrial wastes; second, to determine the potential for synthetic fuel production from solid wastes produced in this country, and to explore the feasibility of providing the heat required for the gasification reactions by coupling a chemical reactor to a solar collector. To meet the first objective, a small-scale fixed-bed flow-through reactor was assembled, and a number of potential catalysts were tested on chars from a number of sources. The alkali metal carbonates are superior to any of the catalysts for gasification with both steam and carbon dioxide at 650 C. With these catalysts, rates of gasification by steam are increased by factors of two to three, and rates of gasification by carbon dioxide, by factors up to 10. The rates are comparable with those observed elsewhere with other carbonaceous materials. To meet the second objective, several possible schemes for coupling a solar collector and a gasification reactor are suggested, and economic analyses of the systems are attempted. It is concluded that a feasible economically attractive system is possible.

ST78 18088 Mass Production of Algae; Bioengineering Aspects for Wastewater Treatment, Protein Production, Fertilizers, Drug and Colloid Manufacture

Goldman, J.C.; Ryther, J.H.

Woods Hole Oceanographic Inst., Woods Hole, MA

BSEC Conf. Nov. 15-18, 1976 Miami, FL

Avail:AIAA, A78-28363 Jnl: Proc. of Conf. p. 367-378 Academic Press, Inc.
New York, NY 1977

It is argued that photosynthetic processes such as algal systems may not be justified if used solely as large-scale energy plantations. However, algal systems employed on a smaller scale in such energy-conserving programs as advanced wastewater treatment, raw protein production, fertilizer, drug and colloid manufacturing, and waste recycling-aquaculture process may be feasible. Particular attention is devoted to variables affecting algal culture growth; these include type of culture system (batch, continuous, or semicontinuous), nutrient source, surface area and depth of the culture, mixing techniques, and residence times.

ST78 18089 Will Photosynthesis Solve the Energy Problem

Hall, D.O.

King's College, London, England

1st IPCSSE Conf. Aug. 24-28, 1976 London, Canada

Avail:AIAA, A78-27891 Jnl: Proc. of Conf., p. 27-50 Academic Press, Inc., 1977
New York, NY

Photosynthesis is defined as the conversion of solar energy into fixed chemical energy ($\text{CO}_2 + \text{H}_2\text{O}$ yields organic material + O_2), the products of photosynthesis representing stored energy. Ways in which solar-biological systems can be realized to varying degrees of efficiency over the short and long term are examined. Some, such as the recycling of biological waste, use of leaf protein, and energy plantations (growing of plant materials for their fuel value) can be put into practice immediately, whereas others may never be feasible. Plant systems can be tailored to suit the energy needs of a country, taking into consideration energy availability, local and fiber production, ecological aspects, climate, and land use. In all cases the total energy input (other than sunlight) into any biological system should be compared with the energy consumed in the construction of any other energy-producing system. Photosynthesis applicability might be immediate in some tropical areas and countries with large amounts of sunshine.

ST78 18090 Development of a Practical Photochemical Energy Storage System, Annual Report June 15, 1976-June 14, 1977

Hautala, R.R.; Kutal, C.R.

Georgia Univ., Athens, GA, Dept. of Chemistry

Avail:NTIS, N78-21628

Significant progress toward the development of a solar energy storage system based on the norbornadiene-quadracycline interconversion was achieved. New sensitizers and catalysts were discovered and conditions found where single cycles of the photosensitization step and the catalytic reversion step appear to be quantitative. Both sensitizers and catalysts were successfully incorporated onto insoluble polymeric supports. The long-term stability of these components is currently being tested using a recently constructed prototype device designed for multiple recycling experiments. Investigations are also underway on design modifications which will allow incorporation of the norbornadiene-quadracycline system into currently available state-of-the-art solar collectors.

ST78 18091 Evaluation of the Photochemical Production of Hydrogen From Solar Energy

Heppert, J.A.

California Univ., Lawrence Livermore Lab., Livermore, CA

Avail:NTIS, UCID-17535 Aug. 9, 1977

The potential for utilizing solar energy through photochemical storage were investigated. Both water and nitrosyl chloride systems are examined. A comprehensive review of the literature led to the conclusion that many major questions must be answered before photochemical energy becomes a viable alternative means of exploiting solar energy.

ST78 18092 International Conference On The Photochemical Conversion and Storage of Solar Energy

Hofman, M.Z.
Boston Univ., Dept. of Chemistry, Boston, MA
Avail:NTIS, CONF-760889 Jan. 31, 1977

Abstracts are given for the eight formal lectures and the contributed papers from delegates which were presented in the form of posters. There were seven sessions divided by subject as follows: (1)photochemistry, (2)electron transfer mechanisms in photochemical energy conversion processes, (3)photoelectrolysis, (4)photogalvanics, (5)photochemical production of fuels in homogeneous solutions, (6)membranes for photosynthesis reactions, and (7)non-biological systems for organic molecular energy storage.

ST78 18093 Application of Solar Energy Bioconversion in Developing Countries

Horstmann, U.
Kiel, Neue Universitaet, Kiel, W. Germany
San Carlos University, Cebu City, Philippines
BSEC Conf. Nov. 15-18, 1976 Miami, FL
Avail:AIAA, A78-28367 Jnl: Proc. of Conf. p. 427-436 Academic Press, Inc. 1977
New York, NY

No abstract available.

ST78 18094 A Model for Solar Radiation Conversion to Algae in a Shallow Pond

Incropera, F.P.; Thomas, J.F.
Purdue Univ., W. Lafayette, IN
Avail:AIAA, A78-28167 Jnl: Solar Energy, V 20:157-165 N2 1978

In recent years there has been considerable interest in solar energy utilization through bioconversion, and a promising application involves the mass culture of unicellular algae. The purpose of this study has been to develop systematic procedures for predicting the yield of such cultures as a function of geographic location and diurnal and seasonal conditions. The procedures allow for the use of available insolation data and account for both the spectral and directional characteristics of the incident radiation. Calculations for the maximum hourly production of algae and oxygen have been performed for the Indianapolis, Indiana region, and the results are in reasonable agreement with field data obtained at similar latitudes.

ST78 18095 Biological Constraints on Seaweed Culture for Biomass Conversion Systems

Jackson, G.A.
Woods Hole Oceanographic Inst., Woods Hole, MA
BSEC Conf. Nov. 15-18, 1976 Miami, FL
Avail:AIAA, A78-28368 Jnl: Proc. of Conf. p. 437-448 Academic Press, Inc. 1977
New York, NY

Attention is given to the design and maintenance of seaweed systems used for biomass conversion applications. Regulation of pH in the maricultures and elimination of harmful concentrations of trace metals from upwelled deep seawater are considered. Transport process limitations in seawater also provide an important criterion for determining maximum seaweed production rates. Self-shading due to excessively concentrated growth may decrease production rates. In addition, losses due to storms and pathogen assaults are mentioned.

ST78 18096 Photon Energy Storage in Organic Materials; The Case of Linked Anthracenes

Jones, G.II; Reinhardt, T.E.; Bergmark, W.R.
Boston Univ., Boston, MA
Avail:AIAA, A78-30267 Jnl: Solar Energy, V 20:241-248 N3 1978
Navy-supported Research

Criteria for the photochemical conversion of solar energy are reviewed in terms of utilization of photoactive organic materials. Endoergic valence isomerizations which may be driven by visible light are proposed for study. These isomerizations store electronic excitation energy as chemical potential energy. Products of the proposed photoreactions are kinetically stable for energy storage over controllable periods. Stored energy is retrieved by thermal or catalytic recycling to the original photoactive substance. Such organic materials are potentially useful as additives to working fluids of conventional

solar-thermal conversion units. Photon energy storage is illustrated in several examples which utilize 300 to 500 nm radiation for isomerizations with storage capacities of about 400 J/g (about 100 cal/g). New data including quantum efficiencies, storage capacities, and conditions for recycling are presented for a series of linked anthracenes. A photocalorimeter capable of direct measurement of storage enthalpies is described. The economic and physical requirements of a photochemical storage material are outlined, and several systems for the conversion of solar energy on an appropriate scale are suggested.

ST78 18097 Thermophotovoltaic Cells for Solar Energy Conversion

Kamat, P.V.; Karkhanavala, M.D.; Moorthy, P.N.
Bhabha Atomic Research Centre, Bombay, India
Avail:AIAA, A78-28169 Jnl: Solar Energy, V 20:171-173 N2 1978

Photoelectric cells employing dye-redox and semiconductor-redox systems are useful because of their transmission in the visible and near-UV regions. Since their absorption is high in the infrared, it has been considered feasible to use IR heating to provide a temperature differential between the illuminated and dark half cells to improve system efficiency. This paper discusses experiments performed using a tungsten-halogen light source and constant water circulation to provide an even temperature. Photoelectrochemical reactions in the system are outlined and the results presented in a graph.

ST78 18098 Biomimetic Approach to Solar Energy Conversion

Katz, J.J.; Janson, T.R.; Wasielewski, M.R.
Argonne Nat'l Lab., Argonne, IL
Avail:NTIS, CONF-770582-1 1977

A biomimetic process is carried out in vitro by an inanimate system or apparatus and is based on methods used by living organisms. Specifically, the prospects for using the methods of plant photosynthesis for solar energy conversion are considered. The discussion is presented under the following headings: Biomimetic Technologies; The Photosynthetic Unit; Chlorophyll as Electrophile (Acceptor); Chlorophyll as Donor; Photoreaction Center Chlorophyll; The Special Pair; Electron Spin Resonance Properties of Chlorophyll-Water Adducts; Chlorophyll-Water Adducts; Models for Photoactive Chlorophyll Special Pairs; Synthetic Photoreaction Centers; and Biomimetic Light Energy Conversion. It is concluded that the prospects for the ultimate success of biomimetic technologies for solar energy conversion depend on the extent to which the details of plant or bacterial photosynthesis are delineated. Although significant advances have been made in the past few years, formidable problems remain.

ST78 18099 Electrolytes Which are Useful in Solar Energy Conversion

Lichtin, N.N.; Wildes, P.D.
US Patent no. 4,052,536 Oct. 4, 1977
Avail:Patent Office

Electrolytes are disclosed which have a wider range of wavelength response and enhanced activity compared to the photoredox system contained therein. These electrolytes contain one or more photosensitizing dyes which luminesce within the range of wavelengths absorbed by the photoredox system.

ST78 18100 Using Sugar Crops to Capture Solar Energy; Biomass Conversion Techniques

Lipinsky, E.S.; McClure, T.A.
Battelle Columbus Laboratories, Columbus, OH
BSEC Conf. Nov. 15-18, 1976 Miami, FL
Avail:AIAA, A78-28365 Jnl: Proc. of Conf. p. 397-410 Academic Press, Inc. 1977
New York, NY ERDA-supported Research

The application of biomass conversion principles to sugarcane, a high-yield product requiring small amounts of arable land, is discussed. For purposes of bioconversion, sugar crops have an advantage over other plants in that they yield directly fermentable simple sugars. Sugarcane yield forecasts for high-quality and lower-quality land are presented; the importance of close-spacing during planting is also assessed. Areas suitable for growing sugarcane in Texas, Louisiana, and Florida are estimated. Harvest costs are also mentioned.

ST78 18101 Some Chemical Aspects of Solar Energy Utilization

Mattox, D.M.

Sandia Lab., Albuquerque, NM

Jrnl: J. Solid State Chem., V 22:31-39 N1 Sept. 1977

For solar energy to have a significant impact on the energy economy of the United States, hundreds of square miles of solar collectors will have to be constructed. The chemistry of materials fabrication and stability will play an important role in the economics of collector fabrication and service life. A review is presented for some of the material aspects of the materials involved and the environments to which they are exposed. In many cases, few data are available on the applicability of materials to solar applications.

ST78 18102 Mutational Analysis of Chlamydomonas Reinhardi; Application to Biological Solar Energy Conversion

McBride, A.C.; Lien, S.; Togasaki, R.K.; San Pietro, A.

Indiana Univ., Bloomington, IN

BSEC Conf. Nov. 15-18, 1976 Miami, FL

Avail:AIAA, A78-28357 Jrnl: Proc. of Conf. p. 77-86 Academic Press, Inc. 1977
New York, NY

Mutant strains of *Chlamydomonas reinhardi* were employed in studying hydrogen photoevolution. An investigation involving anaerobically adapted wild-type cells and two photosynthetically incompetent strains gave evidence that water is the primary source for rapid initial photoevolution. In addition, a mutant strain with a more oxygen-resistant hydrogenase than wild-type cells was sought. Finally, a selection program was initiated to isolate mutant strains with greater resistance to the inhibitory effects of the herbicide domu.

ST78 18103 Hydrogen Production by Marine Photosynthetic Organisms as a Potential Energy Resource

Mitsui, A.; Kumazawa, S.

Univ. of Miami, Miami, FL

BSEC Conf. Nov. 15-18, 1976 Miami, FL

Avail:AIAA, A78-28353 Jrnl: Proc. of Conf. p. 23-51 Academic Press, Inc. 1977
New York, NY Res. supp'd by Gulf Oil Foundation and
Engineering Foundation

Hydrogen production by marine photosynthetic organisms is discussed with emphasis on means to increase the solar energy conversion efficiency of the process and techniques for circumventing problems associated with the sensitivity of photohydrogen production to oxygen inhibition. Cell-free hydrogen production, which eliminates many homeostatic mechanisms found in living-cell hydrogen evolution, is described. Particular attention is paid to techniques for collecting marine photosynthetic organisms and identifying highly active and stable hydrogen-producing species. Floating hydrogen production plants, methane production involving sewage and algae, and uses for the chemical products of algae are also mentioned.

ST78 18104 Photochemical Production of a Fuel

Moggi, L.

Universita di Bologna, Bologna, Italy

1st IPCSSE Conf. Aug. 24-28, 1976 London, Canada

Avail:AIAA, A78-27894 Jrnl: Proc. of Conf. p. 147-161 Academic Press, Inc. 1977
New York, NY

Sunlight is converted into chemical energy in a photochemical fuel-production system, where a chemical product of higher energy than the original substrate but kinetically inert at normal ambient temperature is formed. The storage of the fuel is made possible because of its kinetic inertness. However, when this inertness is removed by increasing the temperature or by using a catalytic device, the stored fuel reacts to yield the original substrate (or some other more stable chemical species) and release energy in the form of heat or electric power, depending on the reaction conditions. Attention is given to direct intramolecular photoreactions, bimolecular redox processes, and photocatalyzed systems. The discussion indicates that some of the systems are not feasible and others are affected by severe limitations and defects. The applicability of a photochemical fuel-production system depends largely on the efficiency and cost of a large-scale plant.

ST78 18105 Biological Conversion of Light Energy into Electrochemical Potential

Nishimura, M.; Yamamoto, Y.; Takahama, U.; Shimizu, M.; Matsuura, K.

Kyushu University, Fukuoka, Japan

BSEC Conf. Nov. 15-18, 1976 Miami, FL

Avail:AIAA, A78-28360 Jnl: Proc. of Conf. p. 143-148 Academic Press, Inc. 1977
New York, NY

The energetics and the relaxation characteristics of the energy transducing processes are discussed for the bioconversion of light energy into electrochemical potential. Cells, spheroblasts, spheroblast membrane vesicles, chromatopores, and reconstituted protoliposome vesicles of Rhodospseudomonas sphaeroides are used in investigating the sidedness of the proton pump and the electric field function in the photosynthetic membranes of the cells. In addition, the relationship between H^+ translocation in chloroplasts and the dissipation of membrane potential is analyzed.

ST78 18106 Possibilities of Biomass From the Ocean: The Marine Farm Project

North, W.J.

California Inst. of Tech., Pasadena, CA

BSEC Conf. Nov. 15-18, 1976 Miami, FL

Avail:AIAA, A78-28362 Jnl: Proc. of Conf. p. 347-361 Academic Press, Inc. 1977
New York, NY Res. Supp'd by Am. Gas Assoc., ERDA, NSF

Upwelling deep oceanic water provided by wave pumps was used in an attempt to fertilize macrocystis (giant kelp) plantations; macrocystis has been suggested as a raw material for methane production. However, the presence of one or more trace elements in the deep water apparently was responsible for inhibiting the kelp growth. It is suggested that EDTA might bind the inhibitory agent and increase production rates.

ST78 18107 A Critical Analysis of Bioconversion With Microalgae; Methane Production

Oswald, W.J.; Benemann, J.R.

Univ. of California, Berkeley, CA

BSEC Conf. Nov. 15-18, 1976 Miami, FL

Avail:AIAA, A78-28364 Jnl: Proc. of Conf. p. 379-396 Academic Press, Inc. 1977
New York, NY

Productivity, net energy, harvesting techniques, species control, and the variability of sewage media are discussed as limiting factors in large-scale algal bioconversion in the US. Methane production from algal ponds could be increased by recycling of nutrients from the methane digester to the ponds; without this nutrient integration, it is estimated that algal bioconversion could provide only one-tenth of a percent of national energy supplies by the year 2000. The energy value of photosynthetic oxygenation and fertilizer production would increase the role of algal bioconversion in the national energy budget.

ST78 18108 The Nature of Pyrolytic Oil From Municipal Solid Waste

Pober, K.W.; Bauer, H.F.

Occidental Res. Corp., La Verne, CA

Avail:AIAA, A78-27806 Jnl: Fuels From Waste, p. 73-85 Academic Press, Inc. 1977
New York, NY

A pyrolysis process is under consideration for the production of synthetic fuel oils from organic solid wastes; the process involves near-ambient pressure, no chemicals or catalysts, low capital investment, variability of temperature, and minimum feedstock pretreatment. Organic solid waste feedstocks tested in the pyrolytic fuel oil production system include animal wastes, rice hulls, fir bark, grass straw, and municipal solid wastes. The system, capable of delivering more than one barrel of pyrolytic oil per ton of as-received refuse, yields a low-sulfur low-ash fuel oil which can be stored and transported.

ST78 18109 Energy From Biomass: An Overview of Environmental Aspects

Roop, R.D.

ORNL, Oak Ridge, TN

Avail:NTIS, CONF-780109-3 1978

Recent literature regarding energy from biomass is reviewed in order to delineate environmental issues and suggest research needed for assessment of this energy option. Potential sources of biomass for conversion to energy include agricultural and forestry residues, municipal and industrial wastes, biomass plantations, and freshwater and marine grown plant material. The impacts of using wastes and of growing biomass for fuel are summarized.

ST78 18110 Organic Molecular Energy Storage Reactions

Sasse, W.H.F.

Commonwealth Scientific and Industrial Res. Organization, Div. of Appl. Organic Chem,
Melbourne, Australia

1st IPCSSE Conf. Aug. 24-28, 1976 London, Canada

Avail:AIAA, A78-27896 Jnl: Proc. of Conf. p. 227-245 Academic Press, Inc. 1977
New York, NY

The paper is concerned with systems that depend on light-induced covalent structural changes in organic compounds which can then produce heat in the second stage. Several key factors governing the performance of energy-storing organic photoreactions delivering heat are identified. Examples of such reactions are described and compared relative to photodimers of anthracenes, photodimers in the naphthalene series, naphthalene-diphenylacetylene photoadducts, dicyclopentadien-1-one, norbornadienes, and 1-ethoxycarbonyl-1H-azepine. Major improvements in storage rate can be achieved by gaining more insight into the influence of structural modifications on photophysical and photochemical performance.

ST78 18111 Photolysis of Water and Photoreduction of Nitrogen on Titanium Dioxide

Schrauzer, G.N.; Guth, T.D.

Univ. of California, San Diego, CA

Jnl: J. Am. Chem. Soc. V 99:7189-7193 N22 Oct. 26, 1977

The photolysis of chemisorbed water on incompletely outgassed TiO_2 powder yields H_2 and O_2 in the molar ratio of 2:1 if conducted under argon. In the presence of molecular nitrogen, O_2 is still formed but the evolution of H_2 is inhibited as chemisorbed nitrogen is reduced to NH_3 and traces of N_2H_4 according to $\text{N}_2 + 3\text{H}_2\text{O} + \text{NHV}$ yields $2\text{NH}_3 + 1.5\text{O}_2$ and $\text{N}_2 + 2\text{H}_2\text{O} + \text{MHV}$ yields $\text{N}_2\text{H}_4 + \text{O}_2$. Iron doping enhances the photocatalytic reactivity of rutile and provides prototypes of solar cells for photochemical ammonia synthesis from N_2 and H_2O .

ST78 18112 Photochemical Conversion and Storage of Solar Energy

Stein, G.

1st IPCSSE Conf. Aug. 24-28, 1976 London, Canada

Avail:AIAA, A78-27890 Jnl: Proc. of Conf. p. 1-25 Academic Press, Inc. 1977
New York, NY

The paper examines whether the systems required for the chemical utilization and storage of solar energy are able to compete efficiently and economically with other forms of solar energy utilization. The future role of wind, photosynthetic biomass (formation of biomass through photosynthesis), and hydroelectric power is discussed. Other topics of interest include electricity generation from solar power by decentralized chemical systems, homogeneous chemical systems for solar energy utilization, and thermally assisted photochemical reactions and photochemically assisted thermal reactions. It is suggested that in the near future some photochemical devices may become competitive with already marketable dry photovoltaic devices.

ST78 18113 Energy From Wastes: An Overview of Present Technologies and Programs

Tillman, D.A.

Materials Assoc., Inc., Washington, D.C.

Avail:AIAA, A78-27803 Jnl: Fuels From Waste, p. 17-39 Academic Press, Inc. 1977
New York, NY

Technologies for the conversion of municipal solid wastes to fuels are reviewed, with emphasis on liquid fuels production, production of substitute natural gas by thermal processing, fluidized-bed combustion, and landfill gas extraction. Mechanical beneficiation of municipal solid wastes, which yields cleaner solid fuels, also figures in the review. In addition, attention is given to pyrolysis systems, including an installation which operates at a capacity of 200 tons per day with either as-received refuse or shredded classified municipal solid wastes. Properties of the fuel gas produced by the pyrolysis systems are compared with those of methane and propane.

ST78 18114 Fuels From Waste, Book

Tillman, D.A.

Materials Assoc., Inc., Washington, D.C.

Avail:AIAA, A78-27801 Academic Press, Inc., 242 p., 1977, New York, NY

Transformation of manure, agricultural crop wastes, urban refuse, sewage solids, industrial process wastes and logging and wood manufacturing residues to fuels is discussed. Technologies considered include pyrolysis systems, fluidized-bed combustion, landfill gas extraction, anaerobic digestion, and wood-waste liquefaction. Among the subjects of the papers are a molten salt gasifier for production of low-BTU gas; hydrogasification of solid wastes; a mobile anaerobic digestion plant for methane production from feedlot residues; biomass conversion of aquatic and terrestrial plants; pyrolytic gasification of black liquors from the Kraft process; and fluidized-bed combustion of petrochemical wastes.

ST78 18115 Fuel Gas Production From Selected Biomass Via Anaerobic Fermentation

Wise, D.L.; Wentworth, R.L.; Kispert, R.G.

Dynatech R/D Co., Cambridge, MA

BSEC Conf. Nov. 15-18, 1976 Miami, FL

Avail:AIAA, A78-28366 Jnl: Proc. of Conf. p. 411-426 Academic Press, Inc. 1977
New York, NY

Fuel gas production through anaerobic fermentation of municipal solid wastes, animal wastes, and seaweed is discussed. The manufacture of methane from coal is also described. Anaerobic digestion is held to be a more desirable alternative for treating solid wastes than conventional sewage sludge digestion. Anaerobic processing of animal waste appears to have the greatest potential for providing a source of fuel gas in the US. In addition, bioconversion concepts may be profitably applied to coal gasification; carbon monoxide, carbon dioxide, and hydrogen are treated through anaerobic fermentation to yield methane.

19,000 LARGE PHOTOVOLTAICS

ST78 19113 Novel Silicon Crystals and Method for Their Preparation

Authier, B.

NASA, Washington, D.C.

Avail:NTIS, N78-21957

Prep. by Wacker-Chemitronic Ges. Fuer Elektronik-Grundstoffe MGH,
Burghausen, W. Germany

Plate-shaped silicon crystals and their preparation by pouring a silicon melt into a suitable mold and then allowing it to solidify in a temperature gradient were investigated. The production of energy by direct conversion of solar energy into electrical energy by means of solar cells takes on increasing importance. While this type of energy production is already the prevailing form today in the realm of satellite technology, its terrestrial application has thus far encountered strict limitations owing to the high price of such solar cells. Of the greatest interest in this connection are silicon cells. A substantial reduction in the semiconductor material costs and the costs involved in the further processing to make solar cells are prerequisites for a rational market growth for solar energy.

ST78 19114 Multi-Wire Slurry Wafering Demonstrations: Slicing Silicon Ingots for Solar Arrays

Chen, C.P.

JPL, California Inst. of Tech., Pasadena, CA

Avail:NTIS, N78-20620

Ten slicing demonstrations on a multi-wire slurry saw, made to evaluate the silicon ingot wafering capabilities, reveal that the present sawing capabilities can provide usable wafer area from an ingot 1.05 m/kg (e.g., kerf width 0.135 mm and wafer thickness 0.265 mm). Satisfactory surface qualities and excellent yield of silicon wafers were found. One drawback is that the add-on cost of producing water from this saw, as presently used, is considerably higher than other systems being developed for the low-cost silicon solar array project (LSSA), primarily because the saw uses a large quantity of wire. The add-on cost can be significantly reduced by extending the wire life and/or by rescue of properly plated wire to restore the diameter.

ST78 19115 Photovoltaic Properties of CDTE P-N Junctions Produced by Ion Implantation

Chu, M.; Fahrenbruch, A.L.; Bube, R.H.; Gibbons, J.E.

Dept. of Materials Sci. and Engng., Stanford Univ., Stanford, CA

Jrnl: J. Appl. Phys., V 49:322-326 N1 Jan. 1978

A surface region about 0.22 μm thick of cadmium-annealed updoped N-type CDTE single crystal was converted to P-type by implantation of 60-keV As^+ ions followed by a cadmium annealing. The electrical properties of the P-type layer were measured, as well as the photovoltaic properties of the P-N junction formed in this way. For illumination by sunlight, an open-circuit voltage of 0.84 v was found in a cell with a solar efficiency of 3.0 percent. The parameters of the junction were determined using a model designed to describe the spectral response of the cell.

ST78 19116 Electricity Generation and Storage for Residences Using LiI_2 Electrochemical Engines to Augment Photovoltaics

Elliott, G.R.B.

LASL, Los Alamos, NM

Avail:NTIS, LA-UR-772330 1977

Electrochemical engines use electrochemical cell reactions and a temperature gradient to convert heat directly to electric power. Such engines can both generate electricity and store electric energy. Application of such engines as used with solar photovoltaic conversion is discussed. Specifically, it is shown that such engines could both store electric energy generated in the daytime for nighttime use, and generate electric power from gas or other fossil heat in bad weather. If the photovoltaics remain expensive, the electrochemical engines themselves could be used to generate electric power from focused solar collection.

ST78 19117 Simplified Fabrication of GaAs Homojunction Solar Cells With Increased Conversion Efficiencies

Fan, J.C.C.; Bozler, C.O.; Chapman, R.L.

Lincoln Lab., MIT, Lexington, MA

Jrnl: Appl. Phys. Lett., V 32:390-392 N6 March 15, 1978

Conversion efficiencies as high as 20 percent of A_{ml} have been obtained for single-crystal GaAs shallow-homojunction solar cells without $Ga_{1-x}Al_x$ as layers. These cells, which are fabricated by a simplified technique that does not require any vacuum processing steps, utilize an N^+P structure with an antireflection coating prepared by anodic oxidation of the N^+ layer.

ST78 19118 Results of Outdoor Real Time and Accelerated Testing

Forestieri, A.F.

Univ. of California, San Diego, CA

ERDA SemiAnnual SPPR Mtg. 1977

Avail:NTIS, CONF-770112 Jrnl: Proc. of Conf.

Real time and accelerated outdoor testing was performed on a variety of samples of interest to the ERDA National Solar Photovoltaic Program. The real time tests were performed at seven different sites and the accelerated tests were performed at one of these sites in southwestern United States. The samples tested were of three different types. Transmission samples were made from the materials under test and the optical transmission was measured before and after exposure to determine changes in transmission. Solar cell test material samples were prepared by attaching the materials under test to solar cells. Solar cell characteristics before and after exposure were used to determine any effect on the fourteen different materials, selected as possible solar cell covers, and one adhesive were tested. Four possible substrate materials were also tested. A total of 478 different samples were tested. Some of these are still being exposed and only qualitative results are available from them.

ST78 19119 High Performance GaAs Photovoltaic Cells For Concentrator Applications

James, L.W.

Univ. of California, San Diego, CA

ERDA SemiAnnual SPPR Mtg., 1977

CONF-770112 Jrnl: Proc. of Mtg.

GaAs/AlGaAs concentrator solar cells have already successfully shown scientific feasibility for very efficient photovoltaic terrestrial power generation. The work described has two broad objectives: demonstration of an even higher level of performance, and progress towards the demonstration of economic and manufacturing feasibility.

ST78 19120 Conversion of Solar Energy Into Electricity

Kettani, M.A.

Petroleum and Minerals Univ., Dhahran, Saudi Arabia

Avail:ATAA, A78-27864

Jrnl: Solar Energy Engng. p. 205-324
New York, NY 1977

Academic Press, Inc.

The four main methods used for the direct conversion of solar energy into electricity are related to photovoltaic power conversion, photoemissive power conversion, photogalvanic power conversion, and photomagnetic power conversion. Indirect conversion methods involving a heat stage are also considered, taking into account the conversion of solar energy into heat, the conversion of solar heat directly into electricity, and the indirect conversion of solar heat into electricity. A description is presented of approaches involving the conversion of solar energy through a mechanical stage. The conversion of solar energy through a chemical stage is potentially also feasible. Attention is given to primary photochemical processes for the conversion of solar energy and basic concepts regarding a solar energy power system.

ST78 19121 Advanced Semiconductor Technology for Alternate Energy Sources: DC to AC Converters

Kleiner, C.T.

Rockwell Int. Corp., Anaheim, CA

Avail:NTIS, N78-19662

Alt. Energy Sources Symp., Miami Beach, FL Dec. 5-7, 1977

Alternate or advanced energy conversion methods frequently require DC to AC conversion since the energy output must be synchronized with an existing utility grid. The objective of this paper is to describe various preliminary system concepts for interfacing advanced solid-state energy converters to the utility grid with a significant potential for reducing initial capital investment. Recent ERDA-sponsored studies have identified the solid-state DC to AC inverter as a key element for further development. These studies indicated that an inverter synchronized to the utility grid can directly transform solar photovoltaic array generated energy to local load (residence) demand with any excess energy feedback to the utility grid. Where the solar energy is insufficient to supply the local load, it is supplemented by the utility grid. Several key issues were identified in the referenced studies. One of these involved the considerable weight and cost associated with the DC to AC inverter/transformer vs. a transformerless inverter that would have "float" with respect to the power grid return. This paper addresses this issue as well as the anticipated solution to the problem using advanced semiconductor technology.

ST78 19122 Solar Energy Conversion

Kilby, J.S.; Lathrop, J.W.; Porter, W.A.
US Patent no. 4,021,323 May 3, 1977
Avail: Patent Office

Solar energy conversion is provided by a structure formed of a plurality of photovoltaic sources. An electrolyte wets the sources. Upon exposure to light, the photovoltaic sources cause a current to flow in the electrolyte producing an electrochemical reaction. The products of this reaction may then be collected and stored. In a preferred embodiment the electrolyte is an aqueous solution of hydrogen iodide, and the hydrogen produced by the electrochemical reaction may be stored, burned as fuel, or used in a fuel cell to produce electrical energy.

ST78 19123 Efficiency of Grating Solar Cells

Kong, A.K.; Green, M.A.
School of Electr. Engng., Univ. of New S. Wales, Kensington, Australia
Jrnl: J. Appl. Phys. V 49:437-442 N1 Jan. 1978

Computer simulation of grating solar cells is used to compare the performance of this type of device with more conventional cell geometries. Criteria for the grating design and their dependence upon substrate properties are discussed. The nature of the back contact to the cell is shown to play an important role in determining the cell efficiency. In order for the grating cell to be competitive in efficiency with the normal cell geometry, the back contact must have minority-carrier blocking properties. The efficiency of cells with ideal ohmic back contacts is limited by geometrical effects. Recent experimental results are analyzed in terms of the results of the theoretical investigation.

ST78 19124 High Concentration Silicon Solar Cells Photovoltaic Concentrator Arrays

Napoli, L.S.
Univ. of California, San Diego, CA
ERDA SemiAnnual SPPR Mtg. 1977
CONF-770112 Jrnl: Proc. of Mtg.

The overall objective of the project is to design, fabricate, and test photovoltaic concentrator arrays with the purpose of reducing the cost of terrestrial photovoltaic power generation. Two 100-watt and two 300-watt, fully operational, passively cooled photovoltaic concentrator arrays are to be delivered under this contract. An analytical evaluation of the production cost of such photovoltaic arrays will be made as a function of production quantity in the 10 kw to 10 mw electrical power output range. The paper deals with the design, fabrication, and evaluation of the solar cells to be used in the concentrator arrays. The two 100-watt arrays have been constructed and delivered. The solar cells for these two arrays were fabricated from six two-inch diameter silicon wafers.

ST78 19125 Monolithic Series-Array Solar Cell System

Warner, R.M.Jr.; Murray, E.M.; Smith, W.K.
Univ. of Minnesota, Minneapolis, MN
Jrnl: Appl. Phys. Lett. V 31:838-839 N12 Dec. 15, 1977

By combining solar cell technology and the dielectric isolation technology that was developed in the early 1960's for integrated circuits, we have fabricated monolithic series-connected multicell arrays. Prototype devices have exhibited an efficiency of eight percent.

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LIST OF ABBREVIATIONS

7th AAM Conf. and RSS Symp.: 7th Aerospace and Aeronautical Meteorology Conf. and Remote Sensing from Satellites Symp.

AES: American Electroplaters' Society

AES CFSC Symp.: AES Coatings For Solar Collectors Symp.

16th AIAA ASM: 16th AIAA Aerospace Sciences Meeting

AIChE Symp. Series, 16th NHT Conf.: AIChE Symposium Series, 16th National Heat Transfer Conf.

AGA: American Gas Association

ASCE: American Society of Civil Engineers

BEI, Inc.: Biomass Energy Institute, Inc.

BHRA: British Hydromechanics Research Association

BNL: Brookhaven National Laboratory

BPNL: Battelle Pacific Northwest Laboratory

CEC: Commission of European Communities

2nd CFFBW Symp.: 2nd Clean Fuels From Biomass Wastes Symp.

CIRSL BSFM: Cambridge Information and Research Services, Ltd.; British Gas School of Fuel Management

CIT: California Institute of Technology

DAA: Development Analysis Associates

Proc. of ECASEC Conf.: Proc. of Economic and Commercial Assessment of Solar Energy Conversion Conf.

3rd Annual ECS Conf.: 3rd Annual Energy Conversion and Storage Conf.

EEC Symp.: Environmental and Energy Conversion Symp.

1st SemiAnnual EPRI SPR Mtg.: 1st SemiAnnual EPRI Solar Program Review Meeting

ERDA FWHRU Workshop: ERDA Fluid Waste Heat Recovery Utilization Workshop

ERDA SemiAnnual SPPR Mtg.: ERDA SemiAnnual Solar Photovoltaic Program Review Meeting

1st ERDA SemiAnnual SPCP Conf.: 1st ERDA SemiAnnual Solar Photovoltaic Conversion Program Conf.

FCST: Federal Council for Science and Technology

Conf. on Improving Efficiency in HECFRSCB: Conf. on Improving Efficiency in HVAC Equipment and Components for Residential and Small Commercial Buildings

IAMT Conf.: Inter-American Materials Technology Conf.

IEC: International Electronics Conference

12th IECE Conf.: 12th Intersociety Energy Conversion Engineering Conf.

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IEEE PES Summer Mtg: IEEE Power Engineering Society Summer Mtg.
 IF: Industrial Forum
 IGT: Institute of Gas Technology
 IIASA: International Institute for Applied Systems Analysis
 1st IMEFR Symp.: 1st International Materials and Energy From
 Refuse Symp.
 17th ISTS Conf.: 17th International Scientific-Technological
 Space Conf.
 IWES Symp.: International Wind Energy Systems Symp.
 JPL: Jet Propulsion Laboratories
 Keynote Address before LACFL Conf.: Keynote Address before Los
 Angeles County Federation of Labor Conf.
 NCSTD: National Center for Scientific and Technological
 Documentation
 NEF: National Energy Forum
 NRC: National Research Council
 NSHCIC: National Solar Heating and Cooling Information Center
 NSF: National Science Foundation
 NSI: National Space Institute
 OERT: Ocean Energy Research Technology
 OESS Conf.: Ocean Engineering Symposium Series Conf.
 OFEFPSA: Ocean Food and Energy Farm Project Systems Analysis
 OPFA: Office of Petroleum Fuel Affairs
 ORSA and IMS Jt. Nat'l Mtg.: Operations Research Society of
 America and Institute of Management Sciences Joint
 National Meeting
 OSA: Optical Society of America
 PASEWP Workshop: Practical Applications of Solar Energy to Wood
 Processing Workshop
 12th PSC: 12th Photovoltaics Specialists Conference
 PVPC Workshop: Photovoltaics Power Conditioning Workshop
 1977 PVSEC: 1977 Photovoltaics Solar Energy Conference
 SAMT Conf.: Satellite Applications to Marine Technology Conf.
 SIPI: Scientists' Institute for Public Information
 SNAME: Society of Naval Architects and Marine Engineers
 7th SPG Symp.: 7th Synthetic Pipeline Gas Symp.
 2nd STAR Symp.: 2nd Ship Technology And Research Symp.
 STCPCP Proj.: Solar Thermal Conversion Program Central Power Proj.
 Symp. on 5-MW STTF: Symp. on 5-MW Solar Thermal Test Facility
 3rd UP Symp.: 3rd Uranium Plasmas Symp.